How We came to have the Micrometer Caliper*

Historical Sketch of the Development of Fundamental Principles and Improved Features

By Luther D. Burlingame†

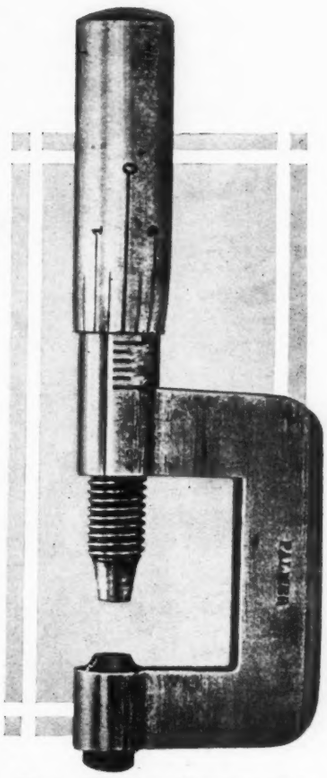

Fig. 1. The Palmer Micrometer which is believed to be the First Micrometer Caliper

In this article, Mr. Burlingame presents a chronological record of the development of the micrometer caliper. Starting with the patent granted to Jean Laurent Palmer, of Paris, France, on September 7, 1848, for the first typical instrument of this type, the development of the different forms of micrometers, and of the improvements which have been made in standard and special purpose instruments of this type, is followed right through to the latest developments of well-known American makers of micrometers.

Luther D. Burlingame‡

THERE seems to be so much uncertainty regarding the origin of the micrometer caliper and the steps taken in its development, and such loose statements have been made concerning these matters, that the subject appears to be one of sufficient importance and interest to warrant bringing the facts together in the form of a brief history. Such a history shows that, like many other important inventions, the micrometer caliper is the result of a gradual evolution, and is the product of many minds and many hands. Of the three great divisions into which all mechanical progress can be grouped, *i.e.*, metallurgy, mechanism and measurement, the micrometer caliper has come to hold a prominent place in the field of measurement.

The First Micrometer Caliper Patented in 1848 by Palmer

The evidence which is now available shows that credit for the origin of this instrument, as we now know it, must be largely accorded to a French inventor and machinist by the name of Jean Laurent Palmer, who was working at the time in Paris. Palmer's "screw caliper," as he called it, was patented in France September 7, 1848, and was manufactured under the name of the "Systeme Palmer." Fig. 1 shows the Palmer caliper as it was made for the market, and Fig. 2 is reproduced from the patent application. There did not seem to be any general appreciation of the importance of this tool until the year 1867, when it was seen by Joseph R. Brown and Lucian Sharpe, when on a visit to the Paris Exposition of that year, where they were exhibitors. They were impressed with the possibilities of such a tool when properly made, and brought one back with them on their return to America. Soon after, they commenced the manufacture of a small sized micrometer, suitable for measuring sheet metal and wire, placing it on the market in 1869 under the name of the "pocket sheet metal gage." The reason for placing this size on the market was that there had been a request from the Bridgeport Brass Co. for a tool to measure sheet brass, following a controversy which had arisen as to the correct thickness of a shipment of sheet brass.

The Laws Micrometer for Measuring Sheet Brass

S. Wilmot, of the Bridgeport Brass Co., had designed a gage for the purpose of measuring this stock and had six of these instruments made by a skilled machinist named Hiram Driggs, under the direction of A. D. Laws, who was then in charge of the mechanical department of the Bridgeport Brass Co. The matter had been taken up with J. R. Brown & Sharpe, with the idea of having them make these gages, and the one shown in Fig. 3 with Mr. Laws' name stamped on it is now in the possession of the Brown & Sharpe Mfg. Co. This tool was not considered to be of commercial value, because the cylinder was so completely covered with spiral and straight lines intersecting each other that it was impossible to put any figures upon it; and without figures, it was very difficult to read. The reading of thousandths of an inch was made by means of a spiral line of the same pitch as the screw running around the cylinder, this being crossed by lateral lines. While the Palmer micrometer had a coarse thread, reading only as fine as tenths of millimeters (about 0.004 inch) and was crudely made, it gave the idea of the present system of divisions; and this system was adopted for the Brown &

* For additional information on micrometers published in MACHINERY see also "Micrometer Caliper as a Machine Shop Gage," December, 1914; "Large Outside Micrometers," February, 1914; "A Three-point Micrometer and Its Uses," May, 1913; "Ball Point vs. Anvil Point Thread Micrometers," May, 1910; and "Some Micrometer Measuring Instruments," September, 1904, and other articles referred to.

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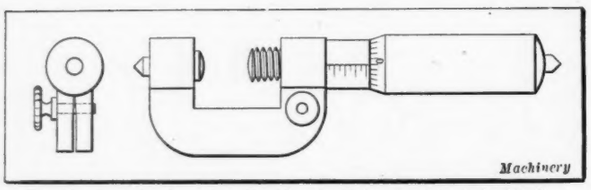

Fig. 2. Reproduction of a Drawing in Palmer's Patent Application

Sharpe pocket sheet metal gage, while the general form of the gage designed by Mr. Wilmot was followed, adding, however, means of compensation for wear of both the measuring screw and the measuring surfaces, as shown in Fig. 4.

It has been suggested that Brown & Sharpe may have got the idea of the micrometer caliper from the screw-operated punch, Fig. 5, which is shown in Vol. II of Holtzapffel, a book which was at that time in their possession. This simply illustrates how little appearances can be depended on to determine who is really the inventor. The introduction of the 1-inch micrometer caliper, Fig. 6, followed that of the pocket sheet metal gage, it being shown in the Brown & Sharpe catalogue of 1877, and here, for the first time, the name "micrometer caliper" was used. It is not known how soon after this date the instrument came to be familiarly called a "mike."

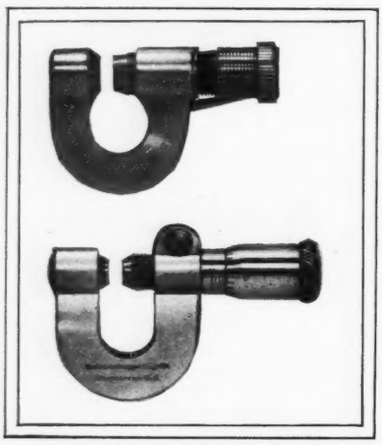

Fig. 3. First American Micrometer—made by the Bridgeport Brass Co.
Fig. 4. Brown & Sharpe Pocket Sheet Metal Gage

The Earliest Micrometer Gages

It must not be understood that because credit has been given to Palmer as the originator of the micrometer caliper, there had not been earlier steps taken to produce micrometer tools for measuring. The earliest that we have record of was a micrometer invented by William Gascoigne of Yorkshire, England, this being described in the "History of Interchangeable Manufacture" by W. F. Durfee, "A. S. M. E. Transactions," Vol. 14, page 1251. It is there stated that Gascoigne's micrometer consisted of two parallel jaws, moved by a screw with a divided head. James Watt also turned his attention to the designing of a micrometer gage, and one of his make, which is shown in Fig. 7, is now preserved in the South Kensington Museum in London. This has a screw and rack adjustment for the sliding jaw with one dial reading for complete turns of the screw and another for fractional turns.

One of the earliest micrometers that our records show to have been made in America is illustrated in Fig. 8; this was made by R. Hoe & Co., of New York, about 1858. This is a bench micrometer with one jaw that can be set to even inches, while the other can be adjusted for divisions of an inch, end measuring bars being used for making the setting. The reading is secured by means of graduations on the dial which forms the head of the adjusting screw. Either inside or outside measurements can be made with this instrument, as will be readily seen.

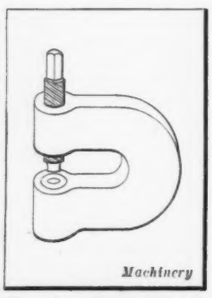

Fig. 5. Screw-operated Punch suggested as Forerunner of Micrometer

Other Early Brown & Sharpe Designs

An early form of micrometer made by J. R. Brown & Sharpe, which was probably designed by Joseph R. Brown, was a sheet metal gage standing on three legs, Fig. 10, the measuring screw being turned from below and the graduated dial revolving with it. This instrument was put on the market in 1867. Another micrometer of Mr. Brown's design, Fig. 9, for measuring up to 4 inches in diameter, was made about 1875. This is in the form of a sliding bar adjusted by a screw and reading to a vernier, one of the measuring points being connected to a series of multiplying levers to make it possible to use this instrument as a limit gage, or to show variations of measurement without resetting.

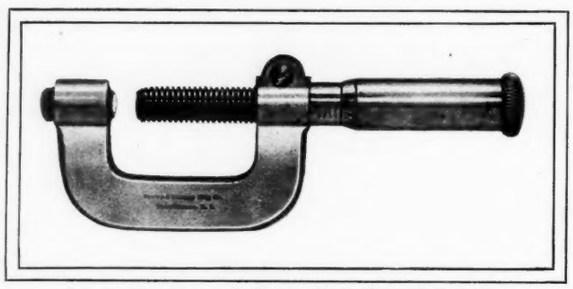

Fig. 6. The Brown & Sharpe 1-inch Micrometer Caliper

The Victor Micrometer Caliper

Pratt & Whitney made a bar micrometer measuring instrument, Fig. 11, about 1881, the micrometer heads for which were made by the Victor Sewing Machine Co., of Middletown, Conn. The latter company was one of the earliest competitors of Brown & Sharpe in the micrometer business. They took up the manufacture of micrometer calipers about 1878, and on April 23 of that year, a patent was issued to one of their employes named George M. Pratt, covering the features of the U-shaped frame and the inserted hardened measuring points. In 1883, Brown & Sharpe bought the micrometer business of the Victor Sewing Machine Co. and

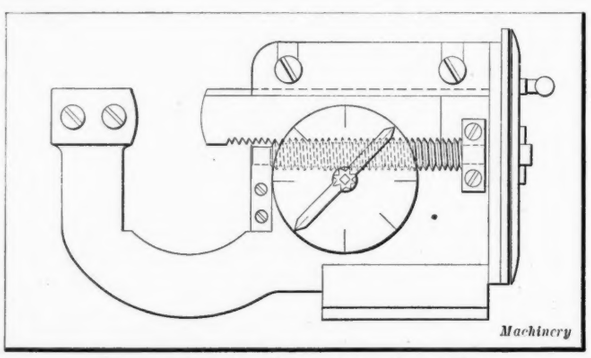

Fig. 7. Micrometer Gage made by James Watt

commenced the manufacture of 1- and 2-inch micrometers, Fig. 12, made under their patents. At the time when this transfer was brought about, Frank Spalding had charge of the making of micrometer calipers for the Victor Sewing Machine Co. and was working as a contractor for them. He, in cooperation with Mr. Pratt, who was superintendent and a stockholder, can be credited with the improved features of

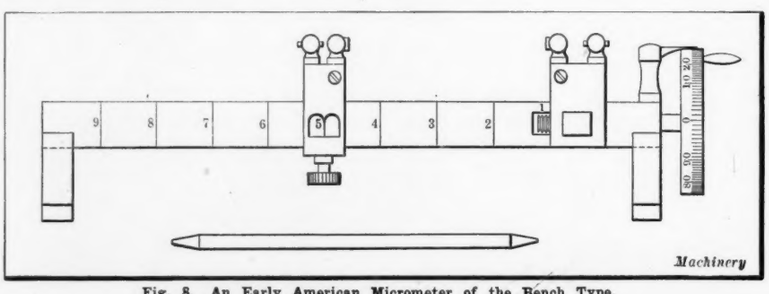

Fig. 8. An Early American Micrometer of the Bench Type, made by R. Hoe & Co., about 1858

design and the very high-grade methods used in the manufacture of their calipers. He was induced to enter the employ of Brown & Sharpe at the time the transfer was made, and brought with him the parts of calipers remaining unfinished. Among these were five hundred frames for 2-inch micrometers, several thousand of this size having already been made and sold before the transfer. These remaining frames were finished at the Brown & Sharpe Works, and new lots at once started.

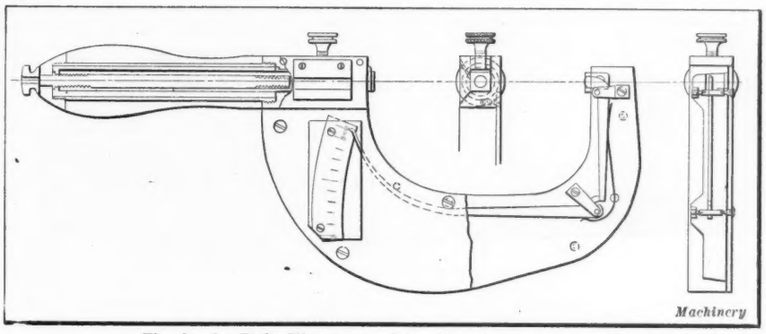

Fig. 9. An Early Micrometer with a Capacity up to 4 inches

Large Size Micrometers

J. T. Slocomb, in the December, 1914, number of MACHINERY, gives the impression that micrometers with capacities above 1 inch were not regularly made for the market until a later date. It will be seen, however, from the above facts, that even as early as 1883 they were becoming widely used. The manufacture by Brown & Sharpe of 3-inch micrometers of the same general design as the 2-inch size, and also of larger sizes, followed soon after the introduction of the 2-inch micrometer. One design of the 6-inch size, made about 1885, is shown in Fig. 13. The making of bar micrometers had been begun by Mr. Spalding before leaving the Victor Works, and was later taken up by Brown & Sharpe, the design being as shown in Fig. 14.

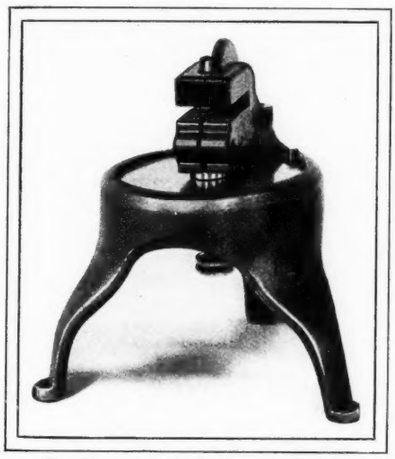

Fig. 10. Sheet Metal Gage designed by Joseph R. Brown

Prof. John E. Sweet invented a micrometer gage for adjustment through a wide range of sizes that also possessed other interesting features, which he patented on March 10, 1885. This gage, which is shown in Fig. 15, was made by the Syracuse Twist Drill Co. There has been a growing demand for larger and larger sizes of micrometer calipers, so that sizes up to 20 inches are now regularly listed, and larger sizes are made to order. Fig. 17 shows a 38-inch size.

Vernier Divisions of Thousandths

In the "reminiscences" of J. T. Slocomb just referred to, mention is made of a 2-inch micrometer caliper which he saw when in the employ of the Brown & Sharpe Mfg. Co., in the possession of one of the foremen. This no doubt refers to a micrometer which was made by William G. Burnham before he entered the employ of the Brown & Sharpe Mfg. Co.; and this micrometer has an interesting history. Mr. Burnham made it while with J. F. Blair & Co., of Camden, N. J. At that time the design of a micrometer with a protected screw had just been brought out, so that the one made by Mr. Burnham, Fig. 16, was of an up-to-date design. Not only this, but he added a feature of refinement in making his caliper with a vernier reading to sub-divide the thousandths of an inch. It was done by graduating parallel lines on the barrel, as shown at *A*. While Mr. Slocomb in his article jokingly speaks of this micrometer as having been "graduated with a monkey-wrench," it is, as a matter of fact, not only well made but accurate to a degree beyond what would have been expected when it is understood that practically all of the operations of screw cutting, graduating, etc., were performed on an engine lathe. This, however, was an engine lathe especially made for precision work. Shortly after Mr. Burnham entered the employ of the Brown & Sharpe Mfg. Co. the feature of providing a vernier to read to ten-thousandths of an inch was adopted for some styles of their calipers. It is not known whether or not this method originated with Mr. Burnham. There is an old French micrometer in the possession of the Brown & Sharpe Mfg. Co. at present which has a similar feature, and which may have been earlier in date than Mr. Burnham's.

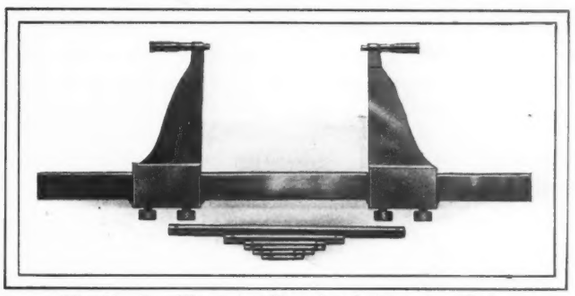

Fig. 11. Bar Micrometer Measuring Instrument made by Pratt & Whitney

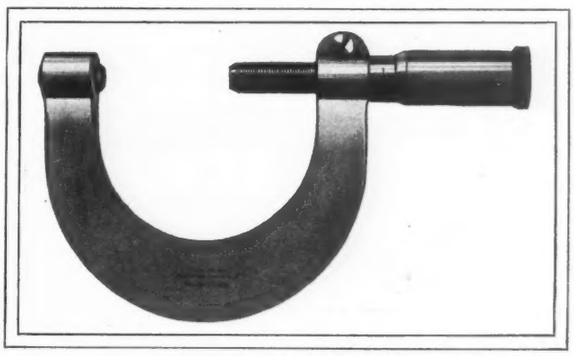

Fig. 12. Victor Micrometer with U-shaped Frame and Hardened Measuring Points

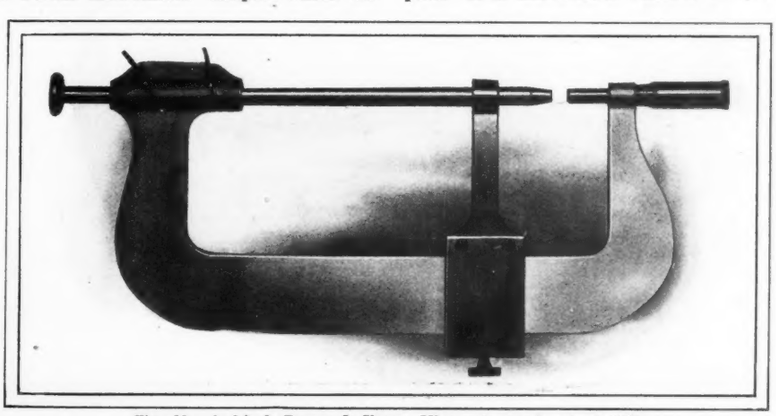

Fig. 13. A 6-inch Brown & Sharpe Micrometer made about 1885

Protected Screw

The feature of having the screw protected and the spindle supported in a bearing at the front

end was first introduced by A. J. Wilkinson, of Boston, being made under the Barnes patent of July 3, 1883. An earlier Barnes patent, dated January 30, 1883, had a cap to protect the screw thread. It was made in the form of a bar micrometer, Fig. 18, and like the Brown design shown in Fig. 9, has means of indicating variations in size by a system of multiplying levers.

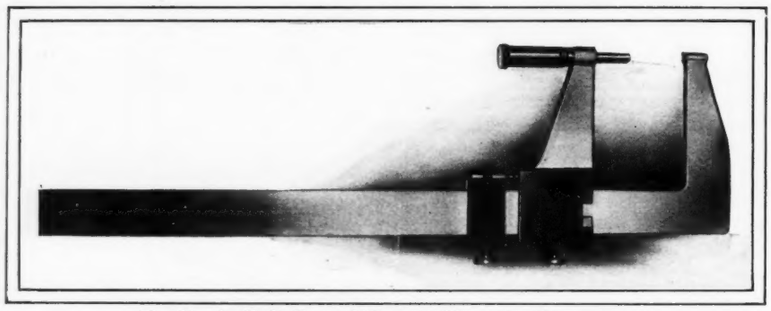

Fig. 14. An Early Form of Brown & Sharpe Bar Micrometer

The Speeder

While not the earliest example of a "speeder" for quickly adjusting the measuring screw, the Barnes micrometer

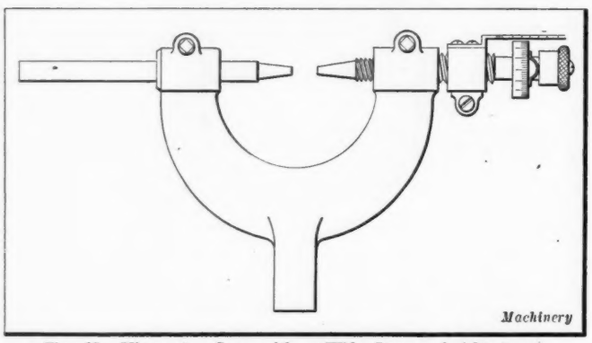

Fig. 15. Micrometer Gage with a Wide Range of Adjustment, designed by John E. Sweet

plainly shows the provision of such a feature. The speeder later became the subject of a patent taken out by L. S. Starrett. About this same time, Cyrus Carleton, a designer in the employ of the Brown & Sharpe Mfg. Co., brought out an improved method of taking up the wear of the adjusting screw; and J. Moffitt, of Southbridge, Mass., made further improvements, so as to avoid having openings exposed to the dirt. The Barnes, Carleton and Moffitt patents were acquired by the Brown & Sharpe Mfg. Co., and in 1884 this firm commenced the manufacture of micrometers, having the features of improvement covered by them, as shown in Fig. 19. Also, for the first time, the practice of stamping decimal equivalents on the frame was followed, this feature also being the suggestion of Mr. Moffitt.

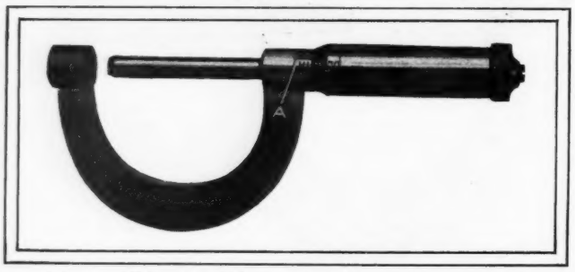

Fig. 16. Micrometer with a Protected Screw and Vernier to subdivide Thousandths of an Inch

The Ratchet Stop

In addition to the speeder for quickly adjusting the position of the spindle, which has already been mentioned, another feature of refinement is the ratchet stop by which the micrometer can be brought to the same reading regardless of the difference in the degree of sensitiveness of touch of different operators. The use of the ratchet for this purpose was patented by George W. Church, of Roseville, N. J., on May 22, 1883, and one of his micrometers having this feature is shown in Fig. 20. It has been claimed that here, again, the French designers anticipated the American; but whether or not the ratchet stop was used prior to the date of the Church patent, friction devices for the same purpose were used at an earlier date; Fig. 21 illustrates the patent of A. Bonnaz of Paris, dated August 19, 1873.

The Clamping Device

An important feature in the development of micrometer calipers consisted of providing a clamping device, so that the spindle could be locked in position without changing its setting in the slightest degree, and many efforts were made to solve this problem. While various means were tried out for this purpose, the early designs were faulty, because in almost all cases the setting was likely to be disturbed when the spindle was clamped—a defect fatal to the securing of accurate measurements. The importance of this feature has led to persistent efforts being made to remedy the defect. The micrometer on which a patent was granted to Palmer in 1848 was provided with a device, Fig. 2, which might be used either as a means of adjustment for the wear of the screw or as a clamping device. One of the earliest clamping devices which came into practical use, and one which is in use to some extent at the present day, was devised about 1885 by Frank Spalding. This consists of a bushing drawn against the spindle by a clamping screw, as shown in Fig. 19.

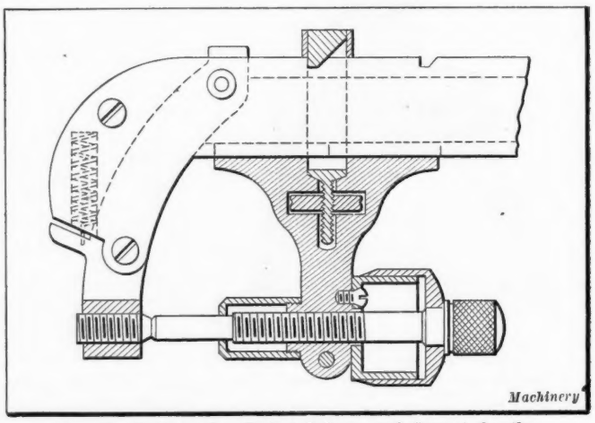

Fig. 18. Feature of a Protected Screw and Support for the Spindle at the Front End

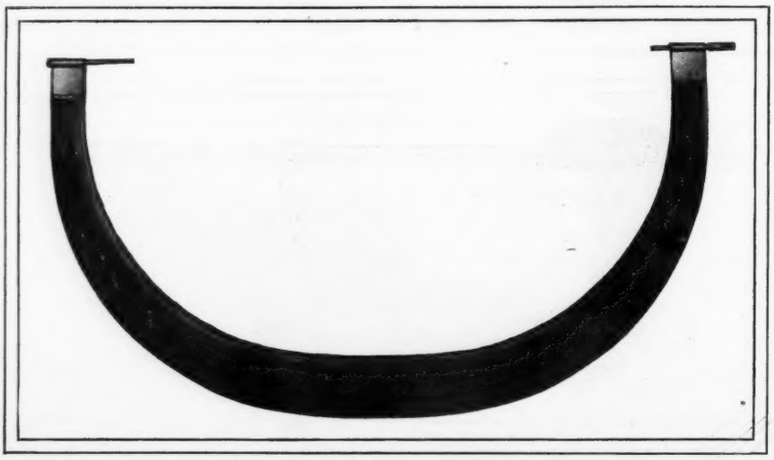

Fig. 17. A 38-inch Micrometer with the Familiar U-shaped Frame

On August 24, 1886, John T. Usher,

of Elmira, N. Y., patented a micrometer gage having an enclosing ring with tapering threads to clamp the spindle in position, as shown at *B* in Fig. 37. This was a gage for inside measurement and will be referred to later under that heading, as it was also one of the earliest inside micrometer calipers. Two years later John A. MacDonald, of Lowell, Mass., brought out a bar caliper, Fig. 22, using a similar means for clamping the thimble in position. In the late eighties, L. S. Starrett took up the manufacture of micrometer calipers, and on July 29, 1890, he also patented a clamp nut for locking the spindle of a micrometer. This had a taper on the inside of the nut instead of using a tapering thread, the design being shown in Fig. 23. On December 30, 1902, Frank Spalding patented another form of clamping device, Fig. 24, especially designed to avoid moving the spindle in the slightest degree when clamping. This clamping device is inserted in a slot in the frame, and is the one now used in the Brown & Sharpe micrometers. To illustrate from how many sources the features of the present-day micrometer have been derived, reference may be made to Fig. 25, where some of these features, together with their inventors, are indicated.

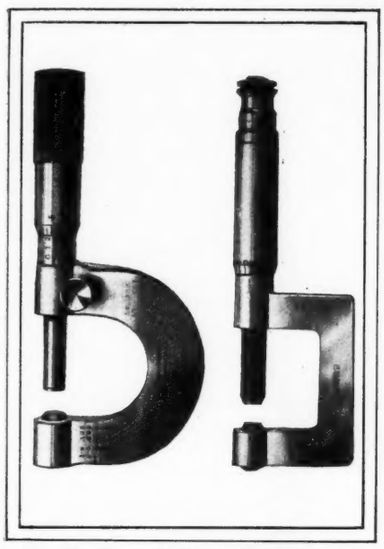

Fig. 19. Brown & Sharpe Micrometer combining Improvements covered by Barnes, Carleton and Moffitt Patents
Fig. 20. Micrometer provided with Church Ratchet Stop

Screw Thread Micrometer

Another application of the micrometer principle is the measuring of screw threads. On December 27, 1887, George E. Whitehead, then superintendent of the Providence Tool Co., secured a patent for a screw thread micrometer, covering practically the same features that are now used. (See Fig. 26.) When he showed this tool to Brown & Sharpe he was taken to a toolmaker, Martin Hiscox by name, who had charge of making and maintaining the tools used in the sewing machine and small tool work. Mr. Hiscox showed him a tool then in his possession having almost identically the same features; and it was afterward learned that J. M. Carpenter, of the J. M. Carpenter Tap & Die Co., had also made a screw thread vernier caliper, Fig. 28, as early as 1875, which may be the earliest tool of this character which was made. Later, Brown & Sharpe and others took up the regular manufacture of screw thread micrometers.

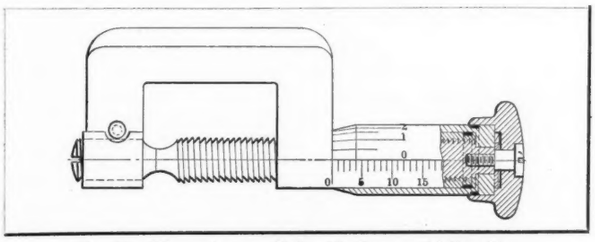

Fig. 21. Micrometer provided with Bonnaz Friction Stop

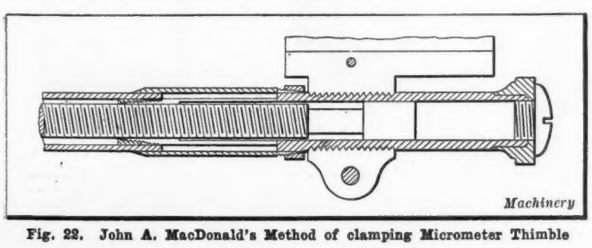

Fig. 22. John A. MacDonald's Method of clamping Micrometer Thimble

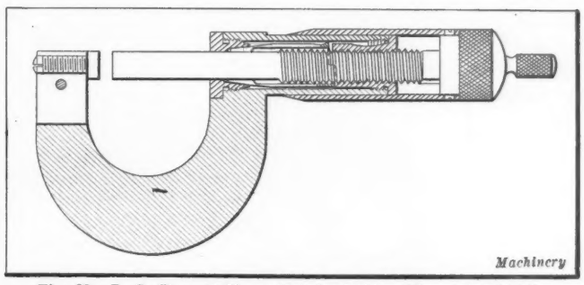

Fig. 23. L. S. Starrett Clamp Nut for locking Micrometer Spindle

Quick Adjustment

Many efforts have been made to provide quick adjustment for the micrometer spindle, so that it could be moved bodily a considerable distance and retain its accuracy when again set. Besides the example shown by the illustration of the Barnes design, Mr. Barnes and other employes of A. J. Wilkinson made many attempts to produce a successful quick-adjusting or "shifting" micrometer. Such a micrometer was patented by L. S. Starrett and C. P. Fay, on September 24, 1889. A patent for the later Starrett design, taken out in the name of L. S. Starrett and J. A. Adell, January 2, 1906, is the one now placed on the market by the L. S. Starrett Co., which is shown in Fig. 27.

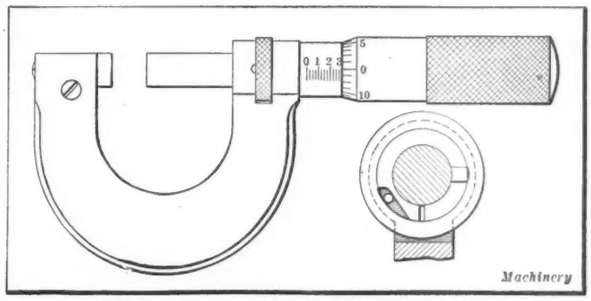

Fig. 24. Form of Clamping Device now used on Brown & Sharpe Micrometers

Direct Reading

Even though the Palmer system of micrometer reading was such a great improvement over any others suggested, the fact that there still remained a possibility of making a mistake in the reading has led to many attempts to produce a direct-reading micrometer caliper. On April 11, 1893, a United States patent was issued to J. Ciceri Smith, of Edinburgh, Scotland, for a direct-reading micrometer, one design of which is shown in Fig. 29. This patent was acquired by the Brown & Sharpe Mfg. Co., although micrometers of this design were never made by them. But it was not until the Spalding direct-reading micrometer, shown in Fig. 30, was developed, during the years 1911-1913, that the point was reached where such a micrometer was successfully placed upon the market. This micrometer was fully illustrated and its working described in MACHINERY for January, 1914.

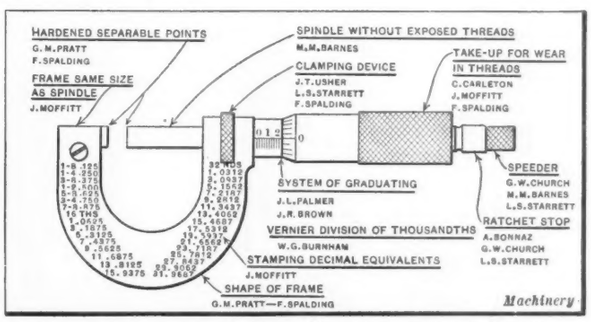

Fig. 25. Features of the Modern Micrometers, and their Inventors

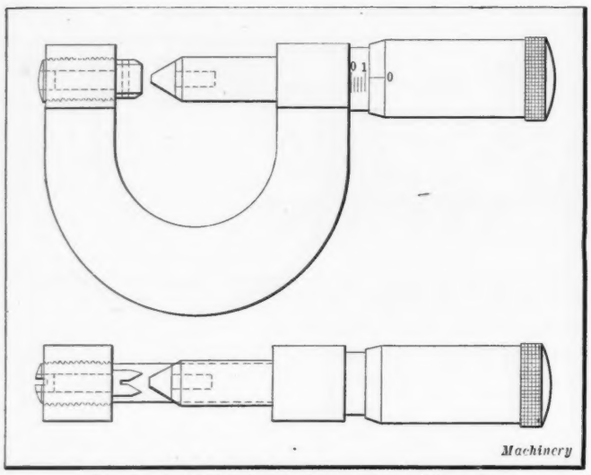

Fig. 26. An Early Type of Screw Thread Micrometer

Heavy Frames

Another recent demand has been for heavy-frame micrometers, made to stand continuous service, and the wear and tear of such work as that handled by the grinding department and others, where the micrometers must be subject to hard usage and sometimes remain clamped in one position for making a large number of duplicate measurements. Such a design, brought out about the year 1911, is shown in Fig. 31. This form of micrometer was first suggested by Charles H. Norton of the Norton Grinding Co., and following the suggestion, Mr. Spalding made a model which resulted in an order for twenty-five each of the 1- and 2-inch sizes for use in the Norton grinding department. Subsequently, this form of micrometer was placed on the market.

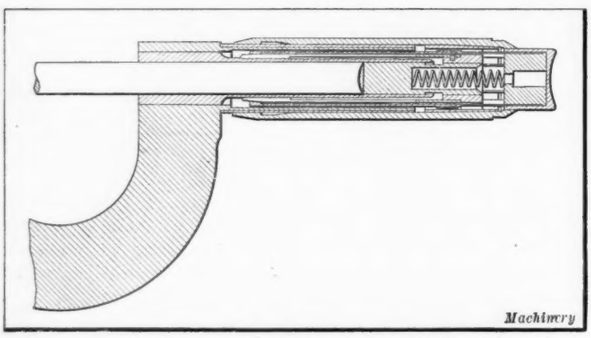

Fig. 27. Mechanism of the L. S. Starrett Quick-adjusting Micrometer

High Finish

The idea usually associated with a fine measuring tool is that it should have a very high finish, and there is a feeling that the care taken by the workman in making a tool has some connection with its finish. It was felt, however, that a need existed for a cheaper form of micrometer, without such high finish; and a line of such calipers was designed and introduced by J. T. Slocomb, a design patent for the same having been taken out by him on April 13, 1897. One of the J. T. Slocomb micrometers is shown in Fig. 32. A new line of low priced micrometers has just been placed on the market by the Brown & Sharpe Mfg. Co., known as the "Rex" micrometers, one of which is shown in Fig. 33. These have been fully described in the May, 1915, number of MACHINERY.

Fig. 28. Screw Thread Vernier Caliper made by J. M. Carpenter 1875 (MACHINERY, December 1912, page 253)

Micrometers for Use in Rolling Mills

Among other forms of micrometers are those for use in measuring at a considerable distance in from the edge of the work, the prototype of which, Fig. 34, was made by Cyrus Carleton about 1882. The present design is shown in Fig. 35, and the opposite extreme used for measuring in restricted places is illustrated in Fig. 36.

Inside Micrometers

The inside micrometer gage seems to have been independently invented by several persons. A patent was issued to John T. Usher, of Elmira, N. Y., on August 24, 1886, for the gage shown in Fig. 37; and this patent claims, among other

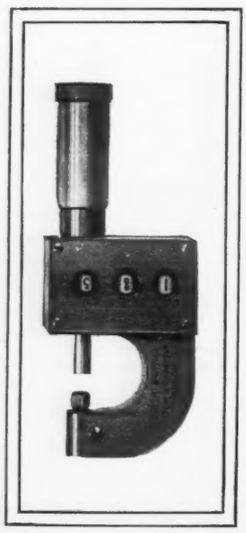

Fig. 29. Direct-reading Micrometer invented by J. Ciceri Smith

Fig. 30. Spalding Direct-reading Micrometer made by Brown & Sharpe

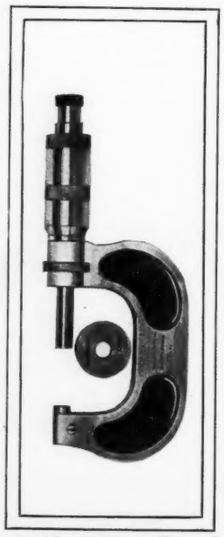

Fig. 31. A Heavy Type of Micrometer adapted for Hard Usage

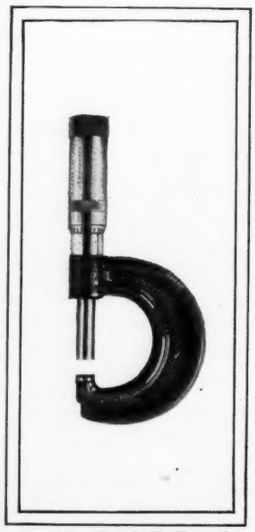

Fig. 32. The J. T. Slocomb Micrometer Caliper with Drop-forged Frame

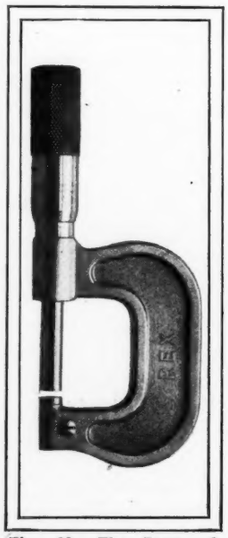

Fig. 33. The Brown & Sharpe "Rex" Micrometer Caliper

features, the use of a handle *A*. Another inventor, David G. Brown, of Philadelphia, made application for a patent for a "micrometer pipe gage" on March 18, 1885; he was apparently ahead of Usher, although his patent was not issued until after Usher's. Brown's gage, which is shown in Fig. 38, may be considered the prototype of the tubular micrometers. On April 26, 1884, John L. Jacobs, then a machinist at the Brown & Sharpe works, made a drawing of an inside micrometer caliper, Fig. 39, of the type which has since been put on the market by that company. The latest type of tubular micrometer made by the same firm, which was designed by Frank Spalding, is shown in Fig. 40. The micrometer principle has been applied to many other forms of tools, such as the micrometer depth gage, etc., each of which has its own stages of development, but practically all can be traced back to the Palmer micrometer, brought to America in 1867 by Joseph R. Brown and Lucian Sharpe.

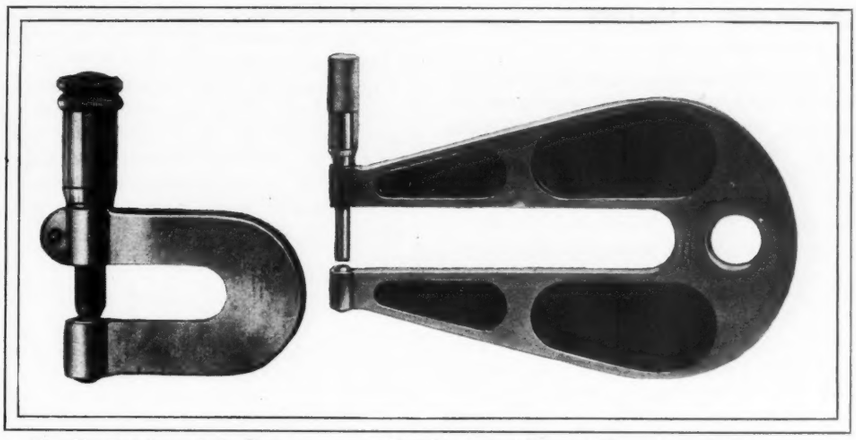

Fig. 34. Prototype of the Deep Bow Micrometer

Fig. 35. Present Form of Micrometer used for measuring at a Distance from Edge of Work

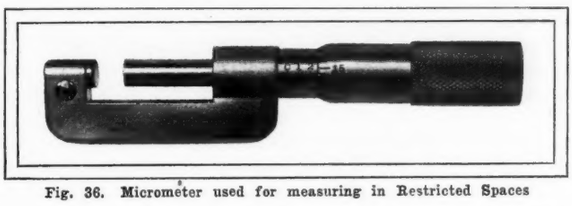

Fig. 36. Micrometer used for measuring in Restricted Spaces

* * *

BIG BUSINESS ECONOMICS

The advantages that flow from large capital wisely invested are quite apparent in modern manufacturing plants, especially those in the metal-working industries. Steel-concrete buildings equipped with the sprinkler system reduce the fire hazard to a minimum; hence the insurance rates are very low and the danger of interruption of manufacturing because of fire is practically eliminated. The modern factory building provides for admitting a flood of daylight, 75 to 80 per cent of the area of the outer walls being glass. Scientifically arranged electric lights provide the illumination necessary to make night work efficient when it must be done. Ventilation by tempered air circulated by the plenum system insures the healthful and comfortable working conditions so necessary for efficient production.

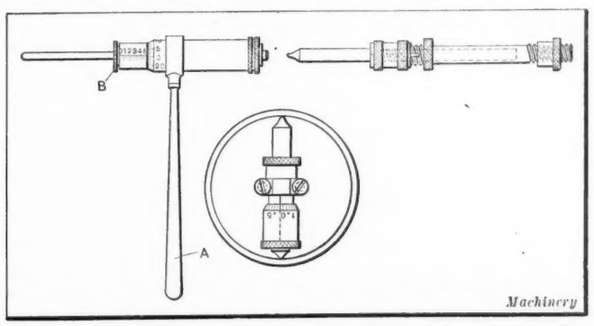

Fig. 37. The "Usher" Inside Micrometer Gage

Fig. 38. "Brown" Micrometer Pipe Gage —Prototype of Tubular Micrometers

Large production makes practicable the use of special machinery which, being designed for one purpose only, subordinates all functions to the one desired. The productive capacity of the employe attending a special machine may be increased ten-fold or even more. Manufacturing on a large scale makes possible scores of economies not worth considering in the small plant. For instance, an automobile concern in Detroit furnishes its workmen in the machine shops with coarse towels instead of waste for wiping off oil. The towels are distributed daily in the morning and collected at night for cleaning. The oil is extracted before washing, and the oil saved in a year amounts to forty barrels.

The development of special machinery for machining the metal parts making up the modern automobile and motor truck has given a tremendous impetus to the design of machine tools generally. The turning of flywheels and camshafts, the milling of cylinders and front axles, the forming of bodies, pans and rear axles from sheet metals, are operations now done with machinery unknown ten years ago.

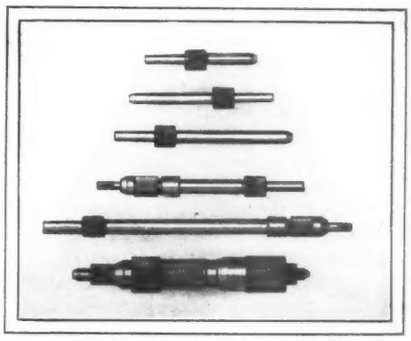

Fig. 39. An Early Type of Brown & Sharpe Inside Micrometer Caliper

Economies of manufacture are not all confined to the large plants by any means, fortunately for the smaller concerns, but the politicians and agitators who rail at all large aggregations of capital as menaces to American institutions should learn to discriminate between those engaged in legitimate production and those which seek by monopolization to make up for brains and enterprise. For these we have no use—they are brakes on progress and dangerous to public welfare—but it is evident that the costs of manufacture rising generally in all lines can be most effectively checked by the development of large and efficient manufacturing plants and their sales organizations.

* * *

A device has been designed, states the *Scientific American*, which will show if an automobile is used without the authority of the owner. The device consists of a small case containing clockwork which unwinds a strip of paper past a needle. The needle is fastened to a carefully balanced pendulum and perforates the paper when moved by the vibration of the car. The tape is marked off in divisions of time, so that the perforations indicate not only that the car has been used, but also how long.

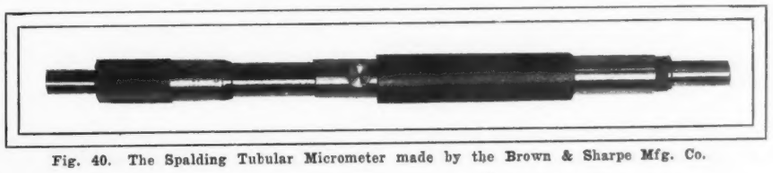

Fig. 40. The Spalding Tubular Micrometer made by the Brown & Sharpe Mfg. Co.

THREAD TOOL GAGES

BY CORRESPONDENT

During the many years that the writer has been engaged in the making of thread gages and the necessary tools for their accurate production, there have been few problems harder to solve than that of making the thread tools themselves, with which these gages were to be threaded, of the required accuracy. The limits of this accuracy are reduced to a minimum, especially when considering the soft—not hardened or ground—master gages, where the final finishing touches cannot be left to the grinding or lapping operation.

Before the advent of the thread micrometer, the art of making thread plug gages, as far as the gage-maker was concerned, was a comparatively simple one, there being hardly any accurate check on him. The means generally employed at that time in gaging thread tools consisted only of a regular bevel protractor for the measuring of the angle, and a plain micrometer for measuring the width of the flat on the tool, an equipment which, with the present high standard in gage-making, would be considered entirely inadequate and inaccurate. After the thread tool had thus been "correctly" made, the thread plug blank (being of the correct outside diameter) was generally turned down for a short distance at the point to the correct root diameter, and then threaded with the tool mentioned until the point of the thread tool "just touched" this turned down part of the plug gage, and then the gage was supposed to be of the correct size and form of thread. On the United States standard form of thread the inspector had a fairly good check on the gage-maker, as, if the gage was correctly made, the flat on the top and in the bottom of the thread of the gage should be exactly alike, an inspection which can be more accurately performed with the naked eye than anyone not acquainted with the facts would be likely to believe, and an inspection which even at the present day must not be laughed at; and it is needless to state that, even with this "crude" inspection, many a thread plug gage had to be made over, owing to incorrectly made thread tools. The procedure followed in making a Whitworth standard thread plug gage was similar, with the exception that the outside diameter of the plug gage was left slightly oversize in order to insure a perfectly round top of the thread when the point of the thread tool "just touched" the turned down part, at which time, if the tool was correctly made, the outside diameter would be correct.

It is interesting to note that, when the thread micrometers first came into use, the Whitworth plug gages were found to be of a much higher degree of accuracy than was found in the United States standard gages, a fact which can hardly be considered very surprising when taking the above procedures into consideration. What the result in accuracy would have been had gages with the United States standard form of thread been made with a sharp bottom of thread, as

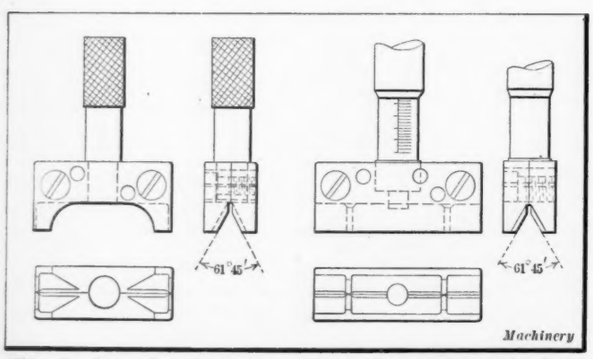

Fig. 1. Gage for measuring Angle of Thread Tools

Fig. 2. Gage for determining Width of Flat or Radius on Thread Tools

is now usually done—for clearance—can easily be imagined.

The best gages for the measuring of thread tools which have come to the observation of the writer are: (1) The gage shown in MACHINERY'S HANDBOOK on page 1036, for measuring the width of the flat on thread tools, and (2) the vernier caliper illustrated in the Brown & Sharpe catalogue of 1913, page 492, for measuring both the width of flat and the angle of 60-degree thread tools.

When considering the *extreme* accuracy, however, necessary in the making of thread tools for gage work, both of these gages have serious drawbacks. The former, owing to its construction, is difficult to make accurately, and when made, the expenses of maintaining its accuracy are considerable. The principle of this gage, however, is excellent and has been embodied in a tool to be described. The second gage mentioned is useful and handy for ordinary thread tools, but does not give the required results when used on thread tools for gage work.

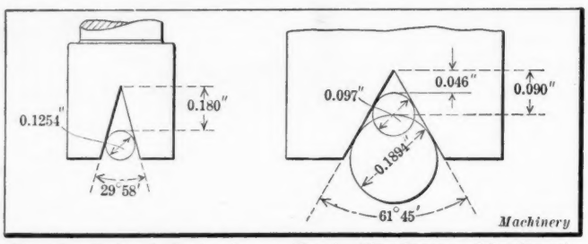

Fig. 3. V-shaped Part of Tool for Acme Thread

Fig. 4. Plug Gages used for inspecting Accuracy of Angle of Gages

The gages now to be described for measuring the width of the flat and the angle of thread tools can be adapted to suit thread tools of any thread angle and with any clearance angle. They have been shown as made for thread tools with 15-degree clearance angle, this clearance angle being the one most universally used by prominent makers of thread tools and thread tool-holders, as for example, the Pratt & Whitney Co., Hartford, Conn., the Western Tool & Mfg. Co., Springfield, Ohio, and others. Tables for use with these gages, figured for tools with 15-degree clearance, will be found in MACHINERY'S HANDBOOK, pages 1036 and 1037.

As can be seen from the illustration, both gages are made in two sections or halves, so as to be able to make them with accuracy and to maintain this accuracy. The accurate grinding or lapping of the angular sides of the gage, as well as the problem of obtaining a sharp bottom, has thus been simply solved; and when repairs are necessary, all one has to do is to take the two halves apart, grind or lap the angles and readjust the micrometer head.

Another feature of these gages is the narrow bearing surfaces of the V (see Fig. 2) these being made narrow so that any slight imperfection on the tool, such as being out of angle or out of straight, etc., will have a minimum amount of influence on the micrometer reading, and thus reduce any possible errors. It will also be noted that these V's are close together, thus still more minimizing any errors in the reading. The gage shown in Fig. 1 is used for testing the angle of thread tools, but can also be used for testing the straightness of the sides; (for this latter, however, a straightedge is equally serviceable). The testing of the angle can be done not only by the sense of feeling but also by vision, moving the tool (or the gage) back and forth once or twice and noticing the bearing surfaces. The gage shown in Fig. 2 can, of course, be used for the same purpose, but being a more expensive gage, both to make and in upkeep, it has not been found practical for this purpose. The V-part of a gage for measuring Acme thread tools is shown in Fig. 3, the angle of the V for this gage being 29 degrees 58 minutes for thread tools with 15-degree clearance. The angles of the V's for Whitworth and British Association standard threads, for tools with 15-degree clearance, are 56 degrees 38 minutes and 48 degrees 58 minutes, respectively. The micrometer heads should be adjusted to measure 0 for a theoretically sharp top of thread on the tool.

To illustrate the accuracy of the micrometer readings Y of the gages, as compared with the width X (actual) of the flat, the following may serve:

Error of Y, Inch	Kind of Thread	Error in X, Inch
0.001	U. S.	0.001195
0.001	Acme	0.000535

TABLE FOR DETERMINING FLAT AT POINT OF FRENCH AND INTERNATIONAL THREAD TOOLS

(15-degree clearance angle)

Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2	Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2	Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2	Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2
5.0	0.0206	3.75	0.0154	2.5	0.0103	1.25	0.0051
4.9	0.0201	3.7	0.0152	2.4	0.0099	1.2	0.0049
4.8	0.0197	3.6	0.0148	2.3	0.0095	1.1	0.0045
4.75	0.0195	3.5	0.0144	2.25	0.0093	1.0	0.0041
4.7	0.0193	3.4	0.0140	2.2	0.0091	0.9	0.0037
4.6	0.0189	3.3	0.0136	2.1	0.0087	0.8	0.0033
4.5	0.0185	3.25	0.0134	2.0	0.0082	0.75	0.0031
4.4	0.0181	3.2	0.0132	1.9	0.0078	0.7	0.0029
4.3	0.0177	3.1	0.0128	1.8	0.0074	0.6	0.0025
4.25	0.0175	3.0	0.0124	1.75	0.0072	0.5	0.0021
4.2	0.0173	2.9	0.0119	1.7	0.0070	0.4	0.0016
4.1	0.0169	2.8	0.0115	1.6	0.0066	0.3	0.0012
4.0	0.0165	2.75	0.0113	1.5	0.0062	0.25	0.0010
3.9	0.0161	2.7	0.0111	1.4	0.0058	0.2	0.0008
3.8	0.0156	2.6	0.0107	1.3	0.0053	...	.....

Machinery

The amount of error in the width of flat X, if the amount of error in the micrometer reading Y is known, may be found by multiplying the error found in Y by 1.1954 for U. S. form of threads, and by 0.53528 for Acme form of thread.

The tables in MACHINERY'S HANDBOOK already referred to cover the United States standard thread, the Whitworth standard thread and the British Association standard thread. A table giving the value of the micrometer reading for a gage such as illustrated in Fig. 2 when measuring widths of flats of the French and International forms of thread, is not given, however, and has, therefore, been included in this article, as has also a table for the Acme form of thread.

Fig. 4 indicates how plain plug gages may be used for testing the accuracy of the angle of the gage in Fig. 2. If a plain plug gage 0.1894 inch in diameter is used in the V

TABLE FOR DETERMINING FLAT AT POINT OF ACME THREAD TOOLS

(15-degree clearance angle)

Threads per Inch	Micrometer Reading of Gage, Fig. 2	Threads per Inch	Micrometer Reading of Gage, Fig. 2	Threads per Inch	Micrometer Reading of Gage, Fig. 2
1	0.6828	5	0.1287	9	0.0674
2	0.3365	6	0.1057	10	0.0596
3	0.2210	7	0.0893	11	0.0532
4	0.1635	8	0.0768	12	0.0480

Machinery

of a U. S. standard thread gage of the type described, the micrometer reading will be 0.090 inch. If a plug gage 0.097 inch in diameter is used, the micrometer reading will be 0.046 inch. The accuracy of the angle of the gage for Acme tools may be similarly measured; for example, if a plug gage 0.1254 inch diameter is used, the micrometer reading will be 0.180 (see Fig. 3).

* * *

EFFICIENCY OF FORGING HAMMERS

BY C. H. WACKERNAGEL*

The Heim method for determining the efficiency of drop-hammers is based on the results of numerous tests conducted by allowing an ordinary drop-hammer to fall a predetermined distance upon a pure lead cylinder, the height of which is 1.5 times its diameter. The dimensions of the cylinders which have been adopted for use in testing various sizes of hammers (with regard to their falling weight) are given in Table I.

The following formula gives the number of foot-pounds of work done by one blow of the hammer.

Work $= 36.75\ D^3\ [8.85\ A + 13.12(A^2 + A^4)]$ foot-pounds (1)

where D = diameter of lead cylinder;

H = original height of cylinder;

H_1 = height of cylinder after being struck by the hammer;

$$A = \frac{H - H_1}{H}.$$

If the expression inside the brackets in Formula (1) is designated by B, the formula may be expressed in the following form:

$$\text{Work} = 36.75\ D^3B.$$

After the lead cylinder has been struck by the hammer, the value of A is calculated and the number of foot-pounds of work developed by the hammer is then obtained by taking the value of B from Table II and substituting in the formula.

Example

Suppose a 100-kilogram (220-pound) hammer striking 180 blows per minute is allowed to strike a lead cylinder, the original dimensions of which are 50 millimeters (1.97 inch) in diameter by 75 millimeters (2.95 inches) high. After the blow has been struck, the resulting height of the cylinder is 48 millimeters (1.90 inch). From the preceding formula:

$$A = \frac{H - H_1}{H} = \frac{2.95 - 1.90}{2.95} = 0.35$$

$B = 4.9$, from Table II.

Substituting the values of D and B in the formula for the work done by one blow of the hammer, we have:

$36.75 \times 1.97^3 \times 4.9 = 1376$ foot-pounds = work done by one blow.

$$\frac{1376 \times 180}{60} = 4128 \text{ foot-pounds} = \text{work done per second.}$$

TABLE I. DIMENSIONS OF LEAD PLUGS USED FOR TESTING VARIOUS SIZES OF HAMMERS

Falling Weight of Hammer		Diameter of Lead Cylinder		Height of Lead Cylinder	
Pounds	Kilograms	Inches	Millimeters	Inches	Millimeters
66	30	1.18	30	1.77	45
110	50	1.38	35	2.07	52.5
165	75	1.57	40	2.36	60
220	100	1.97	50	2.95	75
330	150	2.36	60	3.54	90
506	230	2.76	70	4.13	105
770	350	3.15	80	4.72	120
1100	500	3.54	90	5.31	135

Machinery

The maximum power required to drive the hammer is 10.3 horsepower. As 1 horsepower is equivalent to 550 foot-pounds work per second, the amount of power consumed by the hammer per second is:

$$10.3 \times 550 = 5665 \text{ foot-pounds.}$$

The efficiency of the hammer is found to be:

$$\text{Efficiency} = \frac{\text{useful work}}{\text{power supplied}} = \frac{4128}{5665} = 72 \text{ per cent.}$$

TABLE II. VALUES OF FACTORS USED IN CALCULATING POWER OF HAMMERS

A	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60
B	1.01	1.63	2.31	3.08	3.94	4.90	5.97	7.17	8.52	10.03	11.73

Machinery

The Heim formula and method of testing may be applied to all types of hammers, but when used on steam hammers the test must be made while the hammer is running continuously and not when set to deliver a single blow. The Heim method is in general use in Germany.

* * *

During the last thirty years, the proportion of factory products to farm products in the export trade of the United States has constantly increased. In 1880 the agricultural products formed about 84 per cent of the total exports, while manufactured products formed hardly 15 per cent. In 1913 the proportion of manufactures in the export trade had increased to nearly 49 per cent, while that of agricultural products was only 46 per cent of the total. This, of course, does not mean that the actual volume of agricultural products has decreased, but merely that the proportion to the manufactured products is less than formerly.

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FLUXES FOR OXY-ACETYLENE WELDING*

METHODS USED IN WELDING CAST IRON, WROUGHT IRON, STEEL, COPPER, BRASS, BRONZE AND ALUMINUM

BY S. W. MILLER†

THOSE who are familiar with oxy-acetylene welding are aware that fluxes, scaling powders, etc., are used; but it is not generally known why the use of these fluxes is necessary. They are sometimes used in the shape of powders into which the welding rod is dipped, thereby transferring the flux to the weld; or they may be incorporated in the welding rod itself. Also a special welding rod containing certain elements may be used in connection with a powdered flux. Inasmuch as each metal has different characteristics and requires different treatment during the welding process, the nature of the flux varies with the metal. Therefore, it will be well to consider each metal separately, first explaining the nature of the difficulties encountered and then describing the remedies which are applied, including, as far as possible, the materials used for making the fluxes. It should be stated here that the manufacture of satisfactory fluxes requires considerable chemical knowledge and, in the majority of cases, should not be undertaken by a welding shop because of the difficulty of getting the proper amount of the necessary elements and mixing them properly, and because it is cheaper, as a general rule, to buy the fluxes from the manufacturers than to attempt to make them.

Cast Iron

Melted cast iron has a great affinity for oxygen, which combines with it to form an oxide of iron or slag. This affinity which molten iron possesses for oxygen is well illustrated by the amount of slag produced during the cutting of steel, this slag being nothing but oxide of iron. In the case of cast iron, the oxide is lighter than the melted metal and does not melt at quite so low a temperature. Being lighter, it rises to the surface which makes it easier to dispose of. Many kinds of fluxes for cast iron are furnished by the manufacturers of welding apparatus, or by manufacturing chemists, which vary considerably in composition, but as far as the writer's experience goes, they differ but little in efficiency. The principle of all of them is to provide some chemical which, at the high temperature involved, will break up the oxide into its component parts. For cast iron the writer has found that a mixture of equal parts of carbonate of soda and bicarbonate of soda makes a very satisfactory flux. Ordinary washing soda is the name commonly given to a somewhat impure carbonate of soda. Bicarbonate of soda is ordinary baking soda. The carbonates can be obtained in a chemically pure condition from the manufacturers of chemicals, but the writer finds no particular advantage in their use. A good way to prepare the flux is to grind the washing and baking sodas together in an ordinary meat grinder, passing the material through the hopper two or three times in order to be sure of securing a thorough mixture. Somewhat more of this mixture will be used in welding than would be the case if one of the high priced fluxes was used; but as both ingredients are obtainable at any grocery store at five cents per pound, the difference in cost more than offsets the difference in the amount used. The action of the carbonates is to combine with the oxygen in the slag, reducing the iron, and allowing the oxygen to pass off in the form of carbon monoxide or carbon dioxide gas.

It will be noticed in the use of a cast iron flux that as soon as a small portion of it is put on the melted iron, the surface of the metal becomes clear and mirrorlike, and that under such conditions the union of the metal in the piece and the metal from the welding stick is easily made. The necessity of using a flux for cast iron may not be thoroughly appreciated, but if any one tries to weld cast iron without it, they will at once experience difficulty. In addition to the use of a flux, it is necessary in the case of cast iron to use a special welding rod which has a large percentage of silicon and a low percentage of manganese and sulphur in it.

When oxy-acetylene welding first became a commercial process, great difficulty was experienced in welding cast iron on account of the hardness of the welds, which prevented their being machined in any way, except by grinding. This was due to the use of ordinary cast iron for welding rods. Such cast iron has comparatively little silicon and considerable manganese and sulphur in it. Silicon promotes the formation of graphite in iron, which makes it soft, while manganese and sulphur have just the opposite effect; so that it will be seen that the use of ordinary cast iron tends to produce white iron or chilled iron containing no graphitic carbon, and which is intensely hard. The increase of silicon and the decrease of manganese in welding rods overcomes these objections and makes possible the production of a soft weld. The manufacturing of such welding sticks cannot be carried out in an ordinary foundry as the iron is not suitable. Therefore, it must be left to those who make a specialty of this work. There are several foundries in the country who do nothing else, and the material can be obtained from them, or from the manufacturers of welding apparatus.

Steel and Wrought Iron

In welding these metals, a flux is not ordinarily used, although there is a certain amount of oxide formed which may be removed by the use of a cast iron flux. The melting points of both soft steel and wrought iron are higher than the melting point of the oxide, and while the oxide is lighter than the melted metal, there is more or less tendency for it to sink into the body of the weld. The judicious use of a small amount of flux will help this difficulty. In welding steel, however, the principal thing to guard against is burning the work, which no flux will overcome, and which ruins the weld beyond repair. While it is not necessary to use a flux in making ordinary steel welds, it is absolutely necessary to use the proper kind of welding rod or wire. The higher the percentage of carbon in the steel, the greater is the danger of burning. The writer does not believe it possible to burn wrought iron, which is simply steel with an exceedingly low percentage of carbon, the only difference between the two metals being due to the method of manufacture, which, in the case of wrought iron, naturally produces a metal with less carbon. Inasmuch as the welding wire is generally of considerably smaller section than the weld, there is a greater liability of burning the wire than the weld. The proper manipulation of the torch will help to overcome trouble from this source, but the necessity of having a welding rod that is not easily burnt is obvious, and therefore iron wire is used.

Ordinary iron wire of the kind purchased in a hardware store is quite impure, containing a considerable amount of slag and other impurities which affect the strength of the weld, because phosphorus and sulphur, which are known to be objectionable impurities in steel, are not eliminated from such wire. These impurities, passing from the welding rod containing them into the weld, seriously impair its strength and ductility. The purest wire that can be found is none too good for use in welding, and wire made from pure Norway iron stock has been found to give the best results. This wire can be obtained from wire manufacturers who make a specialty of its production. Much of it is also imported from Norway, and is handled by manufacturers of welding apparatus. It is foolish to attempt to use an inferior grade of wire in welding steel, as the unsatisfactory results obtained more than offset any slight saving in the cost of the wire.

It should never be forgotten that any weld is a casting, no matter what the metal may be, and that it is impossible to produce as strong a structure in the weld as in the original metal, even with the best welding material and fluxes, unless the weld can be given the same rolling or forging treatment

* For additional information on autogenous welding published in MACHINERY see "Preheating Metals to be Welded by Oxy-Acetylene Process," October, 1912; "The Manufacture of Tubing by Autogenous Welding," January, 1912, and other articles there referred to.

† Address care of Mohawk Welding Works, North Pearl and Tivoli Sts., Albany, N. Y.

as that to which the original metal was subjected. In the case of alloy steels, which are largely used in automobiles, proper heat-treatment must be given in addition to forging of the steel. These results are not often possible to obtain, because the piece cannot generally be forged; nor does it contain the necessary elements for successful heat-treatment, since the joint is not a truly autogenous weld. In addition, no welding shop with which the author is familiar has facilities for conducting such heat-treatments. Therefore, in such cases, a welded piece will not give satisfactory results. This is not the fault of the welder, of the material, or of the flux, but is an inherent limitation of the process. It is, therefore, wise to avoid welding such steel pieces, except in case of emergency or for temporary purposes only.

Copper

There is no necessity for using a flux for welding copper, if the surfaces are clean and if the proper welding rod is used. Ordinary copper is quite free from impurities, because traces of such impurities make it impossible to use the copper. This metal, however, has several peculiar properties. When melted it has a strong affinity for gases, such as hydrogen and carbon monoxide. Oxygen is also absorbed by the melted metal, producing copper oxide which forms a true alloy with the copper, making it brittle and worthless. When the metal solidifies, these occluded gases are given out, leaving the metal a mass of blow-holes. It is, therefore, necessary to provide something which has a greater affinity for oxygen than the copper. This is done by the use of phosphorus, which, instead of being used as a flux, is incorporated in the welding rod. Only a small percentage of phosphorus is required, as none should remain in the weld after it is made, although small traces of phosphorus in copper have no bad effect on its physical properties. It is evident that the production of such welding rods or wire is a matter which should be left in the hands of competent manufacturers. This special copper-welding material can, of course, also be obtained from apparatus manufacturers.

Copper Alloys

The alloys of copper include the various brasses and bronzes, which are exceedingly numerous and of a great variety of compositions. A brass is an alloy of copper and zinc. A bronze is an alloy of copper and tin. These alloys may have added to them lead, antimony, iron, manganese, nickel, etc., in smaller percentages than the main constituents. Inasmuch as it is impracticable in ordinary repair work to determine the percentage of the elements in copper alloys, it is manifestly impossible to make a truly autogenous weld, *i. e.*, one containing the same elements as the piece to be welded. Of course, where the process is used in manufacturing and the composition of the alloy is known, some experimenting will probably enable one to determine the most suitable mixture to use for welding rods; but in repair work it is necessary to find some one or two alloys which will apply to all of the metals that are likely to be met with. This is well taken care of by the manufacturers of welding apparatus and welding material, and suitable rods for general brass and bronze welding can best be obtained from them. The writer has found the best all-around welding material to be manganese bronze, although he has also used Tobin bronze with good results. The so-called manganese bronze is really a manganese brass, because the two principal ingredients are copper and zinc, the percentage of tin being quite small. Rolled manganese bronze rod or wire is quite fluid and makes a very good weld. Tobin bronze is somewhat more fluid, and while in many cases it works well, yet if the melting point of the piece that is being welded is high, due to the presence of a considerable percentage of copper, it may be difficult to get it to melt at the same time as the welding rod; manganese bronze not melting at quite so low a temperature is, therefore, found more satisfactory as a general rule. Tobin bronze is really a Tobin brass, as it consists mostly of copper and zinc.

It should be understood that the percentage of the various elements in both manganese bronze and Tobin bronze may vary considerably, so that they are not alloys of constant composition, the difference depending on the ideas of the manufacturers; but both contain some iron, which appears to give greatly increased strength and makes the essential difference between the properties of these metals and ordinary brass. As all brasses contain zinc, which readily volatilizes under the heat of the torch, the advisability of having a considerable percentage of zinc in the welding rod is apparent. Theoretically, the fluxes for a copper alloy should depend on the composition of the alloy, but while there are some objections to it the writer finds that for all practical purposes ordinary borax gives very good results. To prepare the borax for use, it should be melted and then allowed to cool, after which it is powdered, because in its original condition the borax does not lie quietly in the weld, but foams up and a good deal of it is wasted. It is the writer's experience that greater success is obtained by using a satisfactory welding rod for copper alloys than by varying the fluxes; and it should not be forgotten that when the composition of the piece being welded is unknown, the use of one flux may be satisfactory while another one is not. Borax seems to be the best all-around substitute. In welding brasses and bronzes, care should be taken not to heat the piece too hot. If carefully observed, it will be noticed that at a certain temperature the prepared surfaces will show little globules rising from them. This is the temperature at which the metal from the welding rod should be added. It will be found that if this is done a satisfactory weld will be made, provided the surfaces are clean and a small amount of borax is used as a flux.

Aluminum

At high temperatures aluminum has a strong affinity for oxygen. At ordinary temperatures, pure aluminum is but little affected, but all ordinary aluminum pieces, which are generally alloys of aluminum and copper or of aluminum and zinc, tarnish more rapidly. The tarnish is due to the formation of a thin film of oxide of aluminum. Unlike iron or steel, where the oxidization or rusting goes on indefinitely, the thin film of oxide on the surface of aluminum protects the metal from further attack at ordinary temperatures. However, when aluminum is melted it oxidizes freely, and as the oxide or slag is heavier than the melted metal and melts at a very much higher temperature, the tendency is for it to become mixed with the molten metal and weaken the weld. This action of the oxide makes it very troublesome for a beginner to weld aluminum.

The chemical inertia of the oxide makes it exceedingly difficult to decompose with a flux, even at the temperature of melted aluminum. Fluxes for this purpose, therefore, have to be very strong and chemically active, and one difficulty with those which the writer has used is the after-action on the aluminum, a large number of pieces having been observed in which the metal for some distance around the weld had been seriously injured by this action, although it took some time for the damage to develop. In some cases, instructions are issued that after the welding is done, the piece must be thoroughly brushed off with boiling water to remove the remnants of the flux and prevent this action. It is also the writer's experience that after a weld has been made with a flux, should a crack develop in it or near it, such a crack cannot be welded without considerable difficulty, if it can be welded at all, unless the surface is thoroughly cleaned and the metal in the old weld has been removed. Also, while it is theoretically advisable to use a flux, and while in the case of sheet aluminum it is necessary to do so, there are other reasons in the case of repairs to such castings as automobile crank cases, transmission cases, etc., why the use of a flux is difficult. The principal ones are the condition of the surface before welding, and the fact that it is not desirable in the case of thin sections of aluminum, to prepare the piece by beveling it, as is done in the case of iron and steel. There is considerable shrinkage in an aluminum weld, and it is advisable to resist this as much as possible by leaving the full thickness of the section, the thin edge of a prepared piece having less area and therefore offering less resistance. Of course, this will not stop shrinkage entirely, but it helps to do so.

Again, before any flux can be used, the surface must be

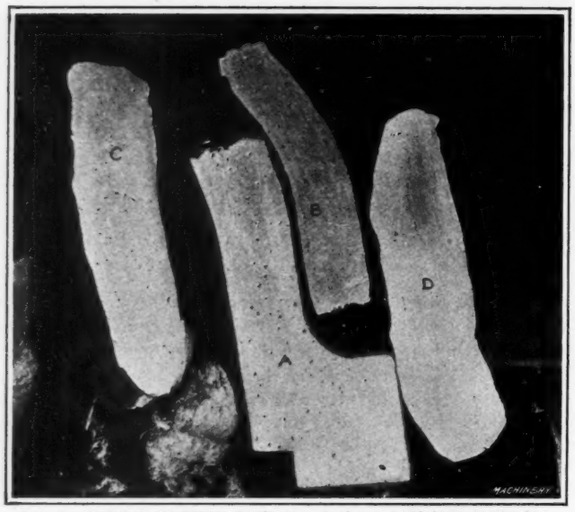


Fig. 1. Polished Aluminum Surfaces. A shows a High-grade Casting before welding; B, C and D show the Surface of another Piece of Aluminum—B before being welded, C after being welded by the Puddling Process, and D after being welded with a Flux

entirely cleaned. Frequently, it is not possible to do this, although the use of strong acid and alkali, such as hydrochloric acid and caustic soda (applied to the work separately), followed by a thorough washing and brushing in water afterward, will remove the grease and dirt from the exposed surfaces. It will not, however, remove the oxide nor, as a general rule, will it remove the grease and dirt from the crack or break, because they are more or less absorbed by the aluminum, which is porous. This absorption extends in some cases for quite a distance from the break, and unless such metal is entirely cut out the use of a flux will be found unsatisfactory. Of course, in some cases it is possible to spring a piece to allow for contraction, but in other cases this is not feasible and other remedies must be resorted to. The narrower the weld, the less the contraction and distortion of the piece, and so the less metal removed the better.

A number of fluxes are sold by the apparatus manufacturers and the chemical companies which vary in composition, and these firms should be consulted as to the best flux to use, the conditions under which it is to be applied being thoroughly explained. Sheet aluminum work is generally a manufacturing proposition, sheet aluminum being used largely for automobile and carriage bodies and similar purposes. A flux is necessary for the proper performance of the work, but as the surfaces are clean the same objections to a flux do not exist as in the case of broken parts, and a proper flux will make the weld just as tough and capable of standing as much work as the original sheet. A flux which was devised in France in the laboratory of the Autogenous Welding Association has the composition given in the accompanying table. A very small amount of this flux is all that is necessary with clean metal, but it should be remembered that it is necessary to wash the flux off carefully, as previously explained. This flux gives a bright red color to the flame when it is applied, which is characteristic of lithium salts. The writer has used this flux and finds that, as would be suspected by one familiar with the chemical properties of its ingredients, it is exceedingly active. It is, however, open to the objections mentioned above.

COMPOSITION OF FLUX FOR WELDING ALUMINUM

Ingredients	Per Cent
Lithium chloride	15
Potassium chloride	45
Sodium chloride	30
Potassium fluoride	7
Potassium bi-sulphate	3

Machinery

In most cases, a weld can be made without the use of a flux in the time taken to prepare the piece so that a flux can be used. Therefore, for practical purposes, the use of a flux in other than special cases is believed by the writer to be inadvisable, and a resort to the puddling of the weld with a rod made of soft steel about 3/16 inch in diameter and bent to the desired shape appears to be the best way out of the difficulty. It is true that more or less oxide is included in welds thus made, but the fact remains that they are plenty strong enough for service and tests show that they are generally stronger than the surrounding metal. This being the case, it is evidently a question whether it is advisable to resort to the use of a flux. The puddling must be thoroughly done and care must be taken to keep the metal melted while it is going on; but if the proper precautions are observed there will be no serious defects visible in the weld through an ordinary magnifying glass, and the work will last as long as the original part. Acquiring the necessary skill to enable one to make a satisfactory weld in this way takes time, and some men never become good aluminum welders. Close observation and the frequent breaking of test pieces will show whether the necessary skill is being acquired, and what is necessary to do in order to overcome any difficulties that may arise. There are two other points to be considered in connection with the use of an aluminum flux. First, there is no casting made that is not more or less porous due to the presence of oxide in it. This being the case, the writer does not see any use in trying to make the weld any better than the casting. Second, even by the use of a flux, it is not possible to make a perfectly sound weld, although it is freer from porosity than one made without a flux. Therefore, the question of the use of a flux with aluminum castings is a practical one rather than theoretical, and in the writer's mind the arguments against the use of a flux carry more weight than those in favor of it.

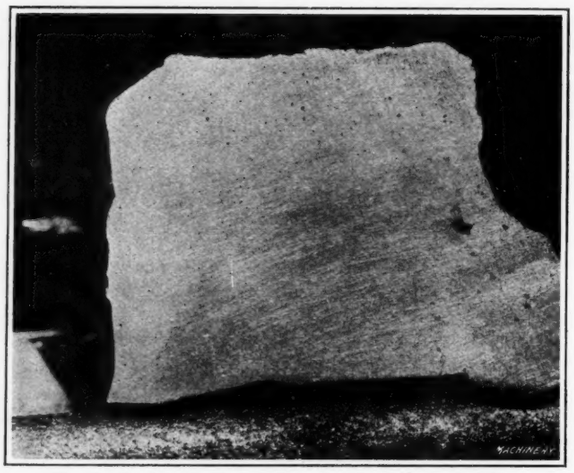


Fig. 2. Section of a Boss built up in Aluminum by Puddling

In support of the writer's contention that a flux is not necessary to get a satisfactory weld in aluminum, he would call attention to the accompanying illustrations. In Fig. 1 it will be noticed that the defects in the original pieces of metal *A* and *B* are as bad or worse than in the puddled weld *C*, while even the weld *D* in which a flux was used, is not by any means perfect. Also, after comparing Figs. 2 and 3, it will again be noticed that while the flux does remove the defects to some extent, the weld so produced is not perfect by any means. In the writer's opinion, it is almost too much to expect that in the operation of welding, a flux can be made to penetrate to all parts of the weld and to come in contact with every particle of oxide no matter how carefully the work is done. It should be stated that piece *A*, Fig. 1, was taken from the transmission case of one of the best automobiles manufactured in this country, and was selected with a view of getting as good a piece of aluminum as possible. The quality of the metal was so good, and it welded so nicely, that the man doing the work commented on it by saying "this is *aluminum*," his meaning being obvious.

The principal alloys used in this country for aluminum castings that the ordinary repair welding shop meets with

are composed of about 93 per cent aluminum and 7 per cent copper; while in England and on the Continent, the general alloy appears to be about 90 per cent aluminum and 10 per cent zinc. In both cases, other elements are present in small quantities. The zinc alloy is somewhat stronger at ordinary temperatures than the copper alloy, but has the peculiar disadvantage of being very brittle at a temperature just below the solidification point. This makes it difficult to cast, particularly if the pieces are of a complicated shape; but while a welder may encounter some of these zinc alloys, particularly in parts cast a number of years ago, at the present time he will find but few of them. This is fortunate and considerably to his advantage, because it is sometimes very difficult to weld an aluminum-zinc alloy on account of the tendency of the shrinkage strains to crack the metal. The writer has frequently found it necessary in such cases to purposely cut the casting at a point where it can be sprung to compensate for the shrinkage, but in several cases has found it impossible, even by doing this, to avoid cracking. A zinc alloy can generally be readily detected by the condensation of the white oxide of zinc fumes on the colder parts of the casting. In such cases, thoroughly preheating the whole piece to the highest safe temperature undoubtedly helps to reduce the shrinkage strains. The writer finds that the welding rod for aluminum is very satisfactory if made of what is known as No. 12 mixture, containing 93 per cent of aluminum and 7 per cent of copper, and which can be obtained from the aluminum manufacturers in pigs. Any good aluminum foundry can cast from these pigs into sticks of the desired size, or they can be obtained from any of the manufacturers of welding apparatus.

Malleable Iron

This metal is a very peculiar one, and on account of its method of manufacture, but little is generally known of its peculiarities and characteristics. Cast iron contains two kinds of carbon, one of them combining with the iron and making iron carbide, which is a true alloy, and the other existing free in the state of graphite. The graphite is in the form of thin plates or flakes which break up the continuity of the iron, and its presence accounts for the comparatively low strength of cast iron. White iron or chilled iron has no free carbon in it, all of the carbon existing in the combined state as carbide of iron. Malleable iron is manufactured by packing white cast iron in boxes filled with some pulverized material as iron ore, lime or sand and subjecting it to a high temperature for several days, so that some of the combined carbon is partly removed by being oxidized; but it is mostly changed into a third condition which is called "temper carbon." This latter change cannot take place in the presence of any appreciable amount of graphite, which is the reason for using white iron in the process.

It is not necessary to go further into the metallurgy of malleable iron, except to say that the quality of a malleable iron casting depends on the material in which it is packed during the annealing process, on the time to which it is subjected to the heat, on the temperature, and on the original quality of the material from which it is made. If the casting is small, if it is packed in such a material as iron oxide, and if it is subjected for a long enough time to a sufficiently high temperature, a large percentage of the carbon may be eliminated, resulting in the formation of a crude steel. Such castings can be welded with ordinary steel welding wire and very good results obtained. In a thick casting, however, particularly if it is not packed in iron oxide or some similar material, the action is different, and the resulting metal is not a crude steel but a form of cast iron, except on the outside, where there will be a thin layer of the steel formation. A welder who observes closely, will notice that such a casting acts peculiarly. The outside skin is hard to melt and acts as steel does under the torch; while the center part acts more like cast iron, becomes full of blow-holes, and cannot be welded with steel, but will weld readily with cast iron, as in fact the whole section will do. At times such a weld is strong enough, but it has only the strength of the cast iron and will tend to be extremely hard.

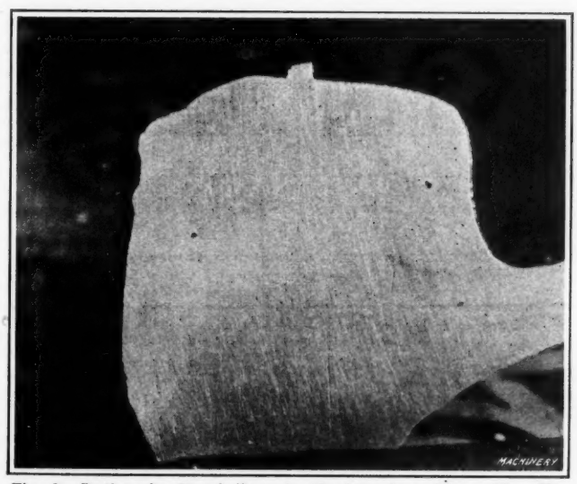


Fig. 3. Section of a Boss built up in Aluminum by welding with a Flux

A little thought will show why this is naturally the case. The original metal of which the casting was made, was cast iron of such a composition that it chills, even when poured in sand without a chill plate, so that the melting of the malleable iron tends to return it to its original condition of chilled or white cast iron, which is very hard and brittle. This accounts for the hard spots and brittleness of a malleable iron weld made with malleable iron welding rods. Of course, it is possible to eliminate these difficulties by again putting the piece through the malleabilizing process, but this is not possible in ordinary repair work, so that other means must be resorted to for joining the broken parts. It is impossible, therefore, to produce a truly autogenous weld in malleable iron without putting it through the malleabilizing process. Experience has shown that the most satisfactory and practical way of joining broken malleable iron parts is by using manganese bronze of the proper composition. Care should be taken not to heat the malleable iron too hot, and it must not be melted, but only brought to the temperature at which the bronze will alloy with it, and the weld should be somewhat reinforced. Borax used as a flux gives very good results.

It should be remembered in all discussions of fluxes that the flux used depends upon the kind of welding material used and *vice versa*, as well as on the material which is being welded; so that no general rules can be laid down governing all cases. More or less experimenting has to be done by every welding shop, particularly by beginners, because they are not able to reproduce at will the same conditions in the use of the torch; and the variations existing from this cause frequently overshadow or entirely obliterate the results obtained by the use of certain fluxes and welding materials. The preceding outline, however, is the result of the writer's experience during the past five years in welding over 16,000 pieces of all kinds and qualities of metal. That there will be changes in the practice of oxy-acetylene welding is undoubted. That new methods will be discovered is not questioned, as it is not to be expected that any process of so recent an origin as oxy-acetylene welding is fully developed. However, the writer believes that the composition of fluxes and welding materials should be determined in laboratories equipped for accurate work, and that rough experimenting without facilities for properly checking and determining the results is a detriment rather than a benefit to the art. He therefore recommends that, except where it is specifically stated above, fluxes and welding materials be either purchased from the manufacturers or from those furnishing the apparatus, and that time and money be not wasted in making experiments that have probably been made before by others better fitted to interpret the results.

* * *

Rotary motors have not been very successful in the automobile field, although they have proved suitable in aeroplanes. The *Scientific American* mentions that an interesting motor of the rotary type, having five cylinders, is used in a new cycle car recently brought out. This motor develops twelve horsepower at 1400 R. P. M.

SECTIONAL VIEWS OF RIBS AND SYMMETRICAL PARTS

CONVENTIONAL METHODS USED IN APPROVED DRAFTING ROOM PRACTICE

BY CARL L. SVENSEN*

THE recent issues of MACHINERY have suggested the existence of a certain interest in the subject of sectioning the ribs of machine parts; and the following article has been prepared to illustrate the proper methods of representation in such cases, and also those where similar treatment is desirable. The question of symmetrical objects generally presents itself as a coordinate subject. The purpose of any drawing is to be useful; and to this end any conventions may be used which are not misleading. Just as orthographic projection cannot be strictly adhered to in all cases, so conventions are not universally applicable. Perhaps in no instances do more conventions appear than in the representing of ribs and in the sectioning of symmetrical and ribbed constructions. A number of cases are illustrated and comments are made on the various methods of representation.

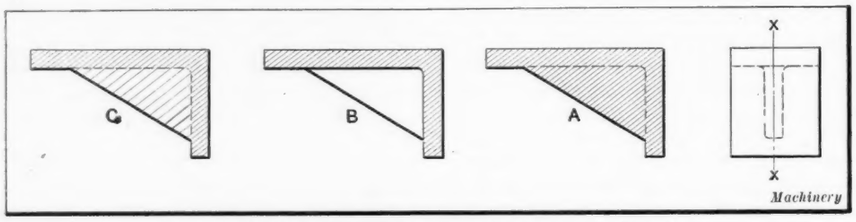


Fig. 1. Methods of showing Cross-sectional Views of Bracket on Line X-X; B and C represent Good Practice

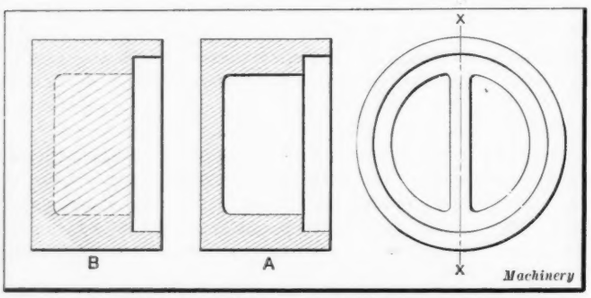


Fig. 2. Methods of showing Cross-sectional Views of Rib in Cup; Either Method is Correct

These are only types, and are not intended to cover every possible case, but simply to illustrate possible correct solutions of typical cases.

Sectional views on planes passing through ribs will be considered first. Fig. 1 shows a bracket with a section taken on the line *X-X*. The true section is shown at *A*, the dotted lines indicating the flanges, but it is hardly necessary to say that no draftsman would think of using such a representation. A generally accepted method is shown at *B*, in which the plane of the section is assumed to have been moved forward until it is in front of the rib. Another method which is sometimes used is shown at *C*, where alternate section lines are omitted from the rib. It will also be observed that in this case the flanges are shown by dotted lines instead of full lines, as the section is taken through the rib. The wider spacing indicates the presence of a rib of small thickness.

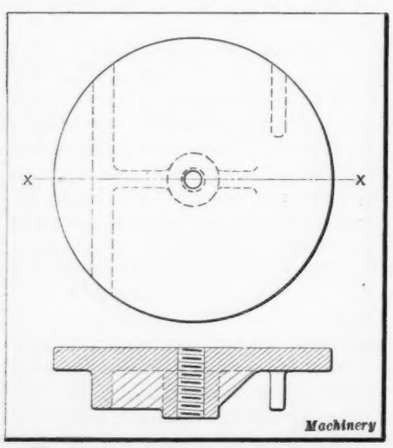
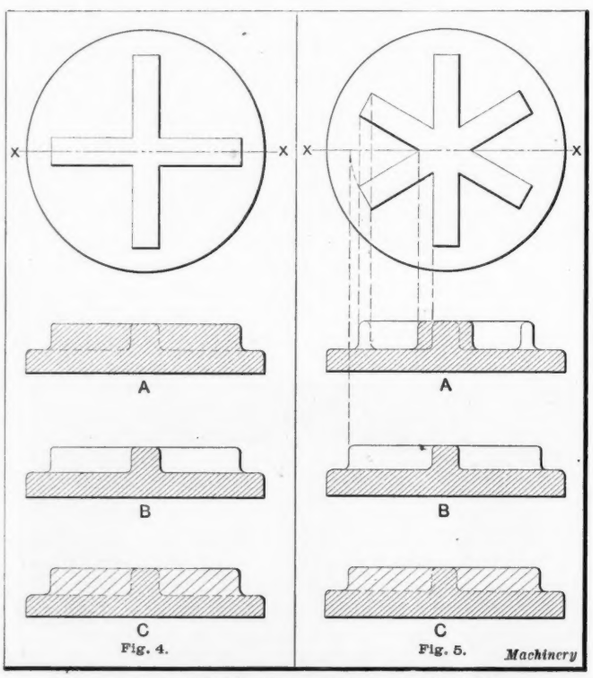


Fig. 3. Correct Method of showing Cross-section of Rib and Hub

Fig. 2 represents an object having a rib as shown in the view at the right. The section on *X-X* as ordinarily represented is shown at *A*, where it will be observed that the presence of the rib is not so evident as it was at *B*, Fig. 1. The view *A*, Fig. 2, would be the same if there was no rib. It is sometimes necessary to show such an object in one view, and it is for such cases that the treatment indicated at *B* is found desirable. One view with such a representation would clearly indicate the fact that there was a rib. However, this treatment of a rib is often convenient and desirable in other cases, as shown in Fig. 3. This appeared in the February number of MACHINERY on page 494, under the title "Drafting Cross-Sections of Ribs," and it might be well to observe that Fig. 3 shows the corrected representation of the object. Note that the outline of the ribs where double sections are used is shown by dotted lines where they join the rest of the object.

Anthony's "Machine Drawing" and French's "Engineering Drawing" both treat of this method of representation, and the author of this article has frequently made use of it to good advantage. Figs. 4 and 5 show ribbed flanges. At *A*, Fig. 4, is shown the true section on *X-X*, which some draftsmen use, but the representation at *B* is more generally acceptable, and would be considered the correct one to use. The alternate method shown at *C* is also a correct representation, but is hardly necessary for such cases. At *A*, Fig. 5, is shown a cross-section on *X-X* which is projected, but it is not as evident as the representation shown at *B* which would generally be considered the correct one. In Figs. 4 and 5 the cross-sections at *B* or *C* might be used without the top views by simply giving the number of ribs in a note, and this would not be likely to lead to any misunderstanding. The representation at *A* would not be as clear. The vertical projection lines in Fig. 5 serve to show the method of obtaining

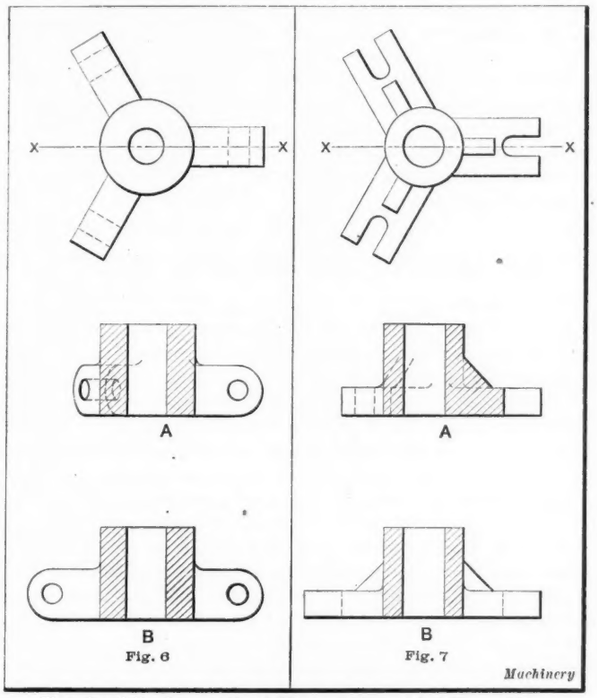


Figs. 4 and 5. Methods of cross-sectioning Ribbed Flanges; Methods B and C represent Good Practice

* Address: Department of Engineering Drawing, Ohio State University, Columbus, O.

the views *A* and *B*. The objection to the method shown at *A* is that the ribs do not appear in their true length. The objection to the representation at *A*, Fig. 4, is that it gives the impression of undue solidity.

The related subject of symmetrical objects is discussed in connection with the remaining illustrations. Fig. 6 shows a section on *X-X* at *A*, in which the lugs are projected. This gives the idea of non-symmetry. The lug lying on *X-X* is treated as a rib and so is not sectioned. At *B* is shown a more desirable representation which should generally be used. Fig. 7 shows the treatment of a similar object, *A* being the true section on *X-X* and *B* the correct representation. Figs. 8 and 9 show the treatment of circular objects with ribs or arms, *A* being the incorrect and *B* the correct representation



Figs. 6 and 7. Cross-sectional Views of Symmetrical Parts; Views shown at B represent Good Practice

in each case. The alternate method shown at *C* is another correct representation of the object shown in Fig. 8. The projection lines show the method of obtaining the sections.

A similar condition arises in representing the holes in flanges, and Fig. 10 shows the correct method in such cases at *C*, where the distance between the holes is made equal to the diameter of the circle of drilling regardless of projection. At *A* is shown the true projection, which is misleading. At

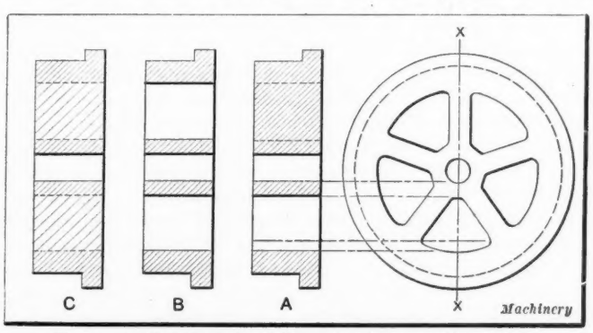
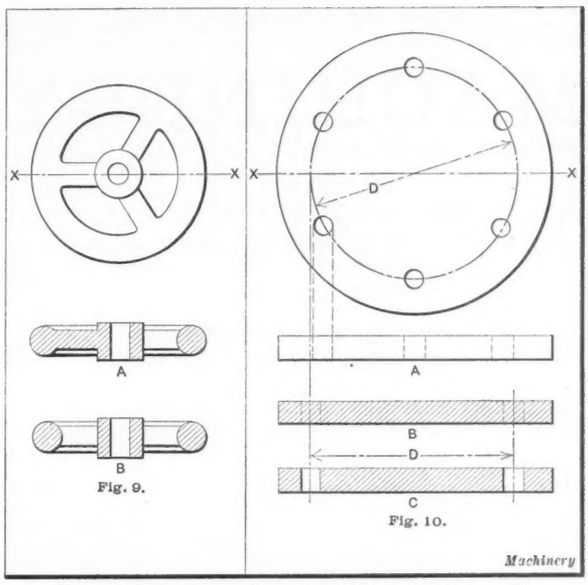


Fig. 8. Another Example of Symmetrical Cross-section; Views B and C represent Good Practice

B the holes are shown dotted, the centers of the holes being the true distance apart. This is a correct representation and is often used when none of the holes are on the plane of the section. Keyways and pins will be considered in the same manner. In Fig. 11 *A* shows the projected section of the hub with the keyway, while *B* is the representation often used to preserve symmetry. At *A*, Fig. 12, is shown the projection of a hole through a shaft for a pin, and *B* and *C* are acceptable



Figs. 9 and 10. Cross-sections of a Wheel and a Flange with Equally Spaced Holes; Views B and C represent Good Practice in showing Holes in Flange

representations of this piece, even though the end view remains the same.

The object in all cases is to give a representation which will most clearly convey the idea. To this end symmetrical objects should appear symmetrical, and the true size should be shown in preference to a foreshortened one. Holes should appear round, and diameters should appear in their true length.

* * *

Advertising has effectively and cheaply solved some of the most perplexing problems of distribution. Supplying postage stamps in hotels and other places where people gather in numbers is an unprofitable and thankless job as ordinarily conducted. Coin-in-the-slot stamp machines that furnish say a two-cent stamp for three cents are failures; the public will not use them if it can be avoided, as the average person strenuously objects to paying a profit of 50 per cent on even a trifle, when he can get the same at cost elsewhere, with a little more trouble. The problem of dispensing stamps without clerical labor and without entailing an extra charge has been solved in some places by providing stamp-vending machines that supply stamps at cost in small envelopes on which local advertising is printed. The advertisers pay for the service at rates which make the installation and up-keep of the machines profitable to the promoters. The service supplies the public with stamps at all hours without troubling a clerk and without extra cost.

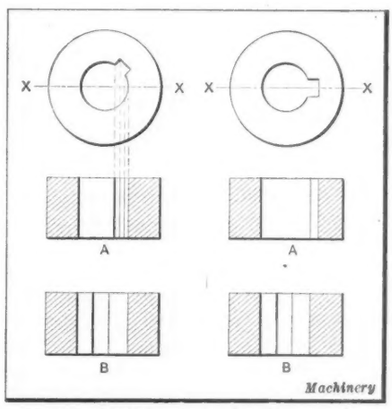


Fig. 11. Methods of showing Keyways in Cross-sectional Views; Good Practice is shown at B in Each Case

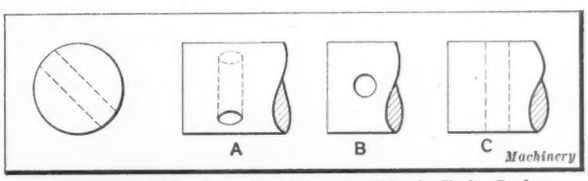


Fig. 12. Methods of showing Transverse Holes in Shaft; Good Practice is shown at B and C

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THE TIME FACTOR IN WAR

A mass of men is not necessarily an army any more than a lot of machined castings is a machine—as the Russians have discovered to their cost. The element of time, which is as necessary for the perfection of an army as of a machine, has played an important, almost a vital part in the war. Lord Kitchener has required eight months to "mold, file, equip and assemble" his army; but the big and little guns, without which the army would be only a helpless mob, and the navy little better than merchantmen, are not provided so quickly.

An arsenal capable of turning out a million rifles a year would require a force of nearly 10,000 men working eight hours a day. This estimate is based on the guarantee of the Pratt & Whitney Co. to equip an arsenal for the Australian government capable of turning out a rifle at a labor cost of twenty-three man-hours, complete from butt-plate to the scabbard for the bayonet.

The United States Government required over nine years to produce its first sixteen-inch sea-coast defense gun, not including the time spent on the plans—nine years to make the special machinery and turn out the first gun. The making of the guns, therefore, is only one of the many things that must be considered. The machinery equipment takes years to produce, because for a gun of that size the machinery is all of a special nature.

When shrapnel is being fired at the rate of 200,000 a day, the production of an enormous plant is being used. Each eighteen-pound shrapnel represents, in labor cost, about forty man-hours or five working days of eight hours each, and 200,000 shrapnel means 1,000,000 man-days labor. When we consider that in a general engagement such as is likely to develop in Europe any day the expenditure of shrapnel may be several times 200,000, we gain some idea of the tremendous cost of war and the imperative need of time as well as equipment for manufacturing munitions.

* * *

SANITARY DRINKING FOUNTAINS

Much attention is being paid by factory managers and engineers to the sanitary equipment of manufacturing buildings, especially as regards drinking water. It pays to install adequate systems for distributing drinking water throughout work-rooms so that employes can quench their thirst without going far from their work, but it is not enough to merely provide taps and cups. The old-time drinking cup is being abolished from all public places, because it has been found to be a prolific means of transmitting disease.

Paper substitutes for common drinking cups are too expensive for use in shops, mills and factories where hundreds or thousands would be used daily, and it can hardly be expected that individuals will scrupulously provide cups for their own use. The bubbling drinking fountain solves the problem hygienically and cheaply. It provides for quenching thirst without recourse to the use of cups, the water bubbling up and being drunk from the stream without the drinker's lips touching anything that will retain contamination. Various forms of these fountains are now available for shop installations—some that run constantly, and others that flow only when a tap is opened by hand, foot or mouth.

The importance of providing sanitary appliances generally can hardly be overestimated. The moral effect of healthful and decent surroundings on employes is reflected in the character of the work produced. Improved conditions in manufacturing plants tend to raise the standard of living in the homes of the workers, and whatever tends to raise the standard of living tends also to raise the mental and moral level of employes.

* * *

THE WIDE-SPACE MILLING CUTTER

Several years ago A. L. DeLeeuw, at that time mechanical engineer with the Cincinnati Milling Machine Co., in a paper read before the American Society of Mechanical Engineers, described a new departure in the making of milling cutters. The difference between the new and old cutters consisted principally in the wide pitch or spacing of the teeth, which was in many cases double that of the practice at that time. In other words, the number of teeth in a cutter of the same diameter was decreased in the new type of cutter to half, or less than half the number previously used. Experiments made with these cutters proved that an equal amount of metal could be removed with considerably less expenditure of power, and that cuts could be taken that had previously been considered impracticable.

Although several years have passed since this discovery, we find today that many users of cutters tenaciously hold on to the old practice of ordering cutters with fine spacing of the teeth. It is claimed that as good a finish cannot be obtained with the wide-space cutter as with the old type. We believe, however, that for the same relation between speed and feed, this objection has been disproved by the originator of the new system; and if the speed is increased to that of which the new type of cutter is capable, as good a finish can be obtained under all circumstances. This is, in fact, admitted even by those who claim that the finish otherwise is inferior.

Here, however, a real objection to the new cutter, as applied to present-day milling machines, is discovered; or, rather, an explanation why manufacturers do not find the new cutter as valuable as might have been expected. The milling machines in use in the average shop have not the power to drive the wide-space cutter at the speed and at the feeds of which it is capable; hence, the cutter, having greater capacity than the machines in which it is used, has little chance to prove its superiority to the average practical mechanic, so that its use has been limited.

In one very large milling department in a shop of the representative type, experiments proved that only the very latest type of plain, large-size, high-power milling machine had the power to drive the wide-space cutters to their full capacity; but as the older types of machines, which do not have sufficient power and which are only a few years old in this particular shop, outnumber the latest types as twenty to one, it is easy to see why the advantages of the new cutters could not be fully utilized yet, even if they were universally used. As a matter of fact, many of the machines still marketed by reputable makers of milling machines can be stalled by the new cutters if they are used at full capacity. It is therefore evident that in spite of the constant increase in size and power of this type of machine tools, the demand is for still more powerful machines.

ALLOWABLE FRICTION VALUES*

EFFECT OF THE SPEED OF ROTATION ON THE OPERATION OF A FRICTION CLUTCH

BY B. D. PINKNEY†

B. D. Pinkney‡

IN the investigation of friction as it pertains to the operation of friction clutches, the generally accepted formulas contain a very uncertain element, *i.e.*, the coefficient of friction, which applies best to the surfaces of bodies that are at rest or to slowly moving bodies. As the purpose of a friction clutch is to "pick up" the load between two bodies, one of which is at rest and the other in motion, there will also be another factor to take into consideration, and that is the temperature. In the "picking up" of the static load and converting it to a rotating load, there should be a certain amount of slippage to prevent unnecessary shocks and danger of breakage; and this will cause abrasion and consequent heating of the clutch. This heating is cared for by the introduction of a lubricant in such quantities as the rubbing velocity of the friction surface necessitates.

It is a generally known fact that a lubricant decreases the friction value; also that the greater the rubbing velocity of the friction surface, the greater is the amount of oil necessary to overcome heating. Hence the higher the rubbing velocity of the friction clutch, the lower is its power in proportion to the speed of rotation. In this article, it is proposed to take the generally accepted formulas used in the design of friction clutches and introduce a factor that will make them better suited to the requirements of practical investigation, by taking into consideration the velocity of the rotating parts.

Unwin, in his "Elements of Machine Design," showed that the moment of the effort required to drive the shaft was (notation slightly changed):

$$M = P_n f r \qquad (1)$$

$$P_n = \frac{M}{fr} \qquad (2)$$

where M = moment of effort required to drive shaft, more commonly known as moment of torsion;

P_n = total normal pressure between friction surfaces, in pounds;

f = coefficient of friction;

r = mean radius of friction surface, in inches.

We get from elementary formula:

$$M = 63{,}025 \frac{H}{N} \qquad (3)$$

We may then express Formula (1) in terms of horsepower as follows:

$$H = \frac{P_n f r N}{63{,}025} \qquad (4)$$

where H = horsepower;

N = revolutions per minute.

Formula (4), therefore, is the fundamental formula for ascertaining the horsepower of friction clutches, and is identical with that given on page 511 of MACHINERY'S HANDBOOK.

VALUES OF ALLOWABLE FRICTION FOR VARIOUS RUBBING VELOCITIES

Rubbing Velocity in Feet per Minute V_f	Allowable Friction in Pounds per Square Inch F	Rubbing Velocity in Feet per Minute V_f	Allowable Friction in Pounds per Square Inch F	Rubbing Velocity in Feet per Minute V_f	Allowable Friction in Pounds per Square Inch F
1	150	150	69	1250	12
5	145	175	63	1500	10
10	140	200	58	1750	8.6
15	135	225	54	2000	7.3
20	131	250	50	2250	6.4
25	126	275	47	2500	5.5
30	122	300	44	2750	4.9
40	115	350	39	3000	4.4
50	109	400	36	3250	3.9
60	103	500	30	3500	3.5
70	98	600	25	3750	3.1
80	93	700	22	4000	2.8
90	88	800	19	4250	2.6
100	85	900	17	4500	2.3
125	76	1000	15	5000	1.9

Machinery

Experiments which the writer has conducted, to determine the effect of introducing oil to prevent abrasion, were for metal surfaces only; and as long as a lubricant was used, it made practically no difference of what metals the friction surfaces were made, *i.e.*, whether they were cast iron on cast iron, cast iron on steel, steel on steel, bronze on cast iron, or any metal combinations.

The following formula gives the allowable friction in pounds per square inch:

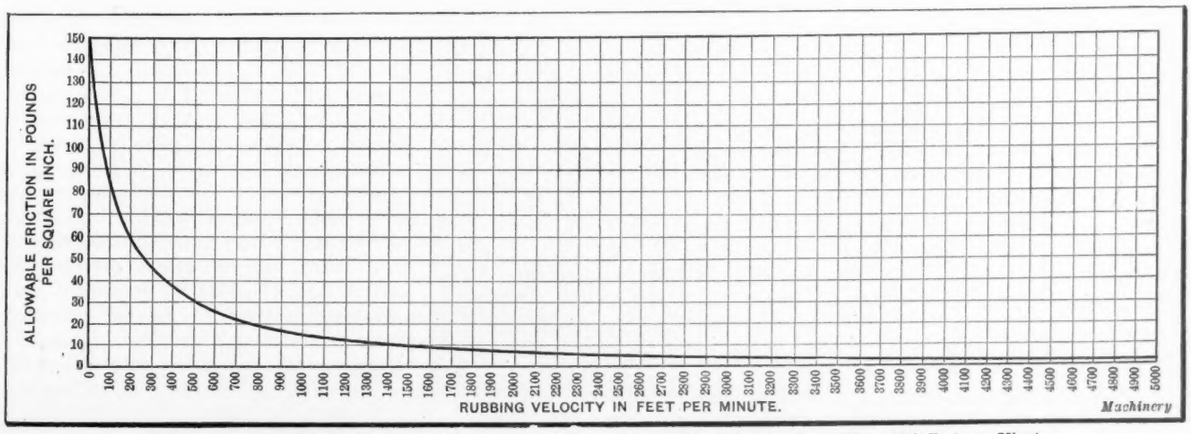
$$F = p_n f t \qquad (5)$$

where F = allowable friction in pounds per square inch;

p_n = total allowable normal friction pressure, per square inch;

t = temperature coefficient (combined with value of F) depending upon rubbing velocity of friction surfaces.

Values of F were found experimentally, and the following



Values of Allowable Friction for Cast Iron on Cast Iron, for Rubbing Velocities from 100 to 5000 Feet per Minute

* For additional information on the design of friction clutches published in MACHINERY, see also "Characteristics of Friction Clutches," August, 1913; "The Design of Clutch Release Shoes," May, 1913; "The Design of Clutch Release Shoes," January, 1913; "The Problem of Cone Friction Clutch Design," June, 1911; "The Problem of Cone Friction Clutch Design," February, 1911; "A Problem in Disk Friction," December, 1910; and "Formulas for Cone Clutches," October, 1909.

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‡ B. D. Pinkney was born in England in 1878. He received a high-school education and an engineering education by private tuition. He has worked for the Western Electric Co., Bucyrus Co., International Harvester Co., E. Goldman & Co., Loew Mfg. Co., J. H. Day Co., holding positions of draftsman, drafting-room foreman, chief draftsman, mechanical engineer, general superintendent, etc. His specialty is machine design and mechanical standardization. He gave up executive positions five years ago to take up experimental work and machine construction, and to do consulting engineering.

working formula very closely conforms to actual practical tests:

$$F = \frac{19{,}900}{V_f + 130} - 2 \qquad (6)$$

where V_f = rubbing velocity of friction surface, in feet per minute.

The velocity chart which has been developed from Formula (6) shows what effect a lubricant has on the lowering of the friction efficiency due to an increase in the rubbing velocity; and the numerical values are given in the table. It will be seen that the value of the allowable friction F drops rapidly for rubbing velocities up to 200 feet per minute, after which the drop is more gradual. It has been suggested that the initial rapid decrease in the value of F is too great, and that the "tractory equation" (see "Higher Mathematics" by Merriman and Woodward, page 149) might furnish a more gradual decrease. This, however, does not agree with practice. The value of F is a maximum one. In the case of a cone clutch or of a disk clutch, the value of F must be computed for the maximum rubbing velocity and not for the mean velocity which is used to obtain the horsepower.

Expressing Formula (4) to suit these new conditions, we get:

$$H = \frac{F 2\pi r^2 WN}{63{,}025} = \frac{Fd^2 WN}{40{,}122} \qquad (7)$$

where W = width of clutch engaging surfaces, in inches;

d = diameter of a straight face clutch, or mean diameter of either a cone or disk clutch, in inches.

In the case of a multiple disk clutch of the Weston type, the mean diameter d is to be multiplied by the number of disks.

The clutch ratings of various manufacturers appear to be for low rubbing velocities of the friction surfaces, where they give good service, especially for machine tools. The manufacturer's chief claims for a good clutch are the proper leverage ratio combined with good wearing qualities. The leverage is an important feature, but the writer has found it advantageous to re-rate the horsepower to suit the conditions of Formula (7). The initial slippage due to the presence of a lubricant furnishes ample protection against abrasion of the friction surfaces and too positive an engagement of the clutch; and the allowable friction per square inch, F, is such that unnecessary wear will not result.

Maple or chemically treated wooden blocks rubbing on cast iron appear to have slightly smaller values of F for low speeds of rotation, but the values are the same for high speeds. The values of F for leather on cast iron vary considerably—possibly on account of the different grades of leather—but the writer uses a value equal to one-third that for metal on metal, and with this value the leather surface has long life. It is seldom that wood is subjected to an oil bath, so that friction clutches with wooden disks or inserts should have a lower rubbing velocity, possibly not over 2000 feet per minute. The advantage of Formula (7) over Formula (4) is the elimination of the uncertain factor f for the coefficient of friction; and the provision of means whereby a suitable working value for the allowable friction F may be obtained to suit the specific case.

* * *

CONVERTING ELECTRICAL UNITS TO HORSEPOWER

BY CHARLES S. OHRENSCHALL*

I have frequently been required to calculate the horsepower developed in conducting various machine tool tests in which the data was in the form of electrical units. For the purpose of facilitating such calculations I worked out the table presented in this connection, which I hope may prove of value to other readers of MACHINERY. It will be seen that the table reads from 75 to 306 volts, which will cover all average conditions under which machine tools are operated. By using the constant opposite the proper number of volts, and multiplying it by the number of amperes, the horsepower developed by the motor is obtained.

CONSTANTS FOR CONVERTING ELECTRICAL UNITS TO HORSEPOWER

Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant
75	0.1005	104	0.1392	133	0.1782	162	0.2160	191	0.2559	220	0.2948	249	0.3336	278	0.3725
76	0.1016	105	0.1407	134	0.1795	163	0.2184	192	0.2568	221	0.2961	250	0.3350	279	0.3738
77	0.1031	106	0.1420	135	0.1809	164	0.2197	193	0.2586	222	0.2974	251	0.3363	280	0.3752
78	0.1045	107	0.1433	136	0.1822	165	0.2211	194	0.2599	223	0.2988	252	0.3372	281	0.3765
79	0.1058	108	0.1447	137	0.1835	166	0.2224	195	0.2613	224	0.3000	253	0.3390	282	0.3778
80	0.1072	109	0.1460	138	0.1848	167	0.2237	196	0.2622	225	0.3015	254	0.3403	283	0.3792
81	0.1080	110	0.1474	139	0.1862	168	0.2251	197	0.2639	226	0.3028	255	0.3417	284	0.3804
82	0.1098	111	0.1487	140	0.1876	169	0.2264	198	0.2646	227	0.3041	256	0.3430	285	0.3819
83	0.1112	112	0.1500	141	0.1889	170	0.2278	199	0.2666	228	0.3048	257	0.3443	286	0.3832
84	0.1124	113	0.1514	142	0.1902	171	0.2291	200	0.2680	229	0.3068	258	0.3457	287	0.3845
85	0.1139	114	0.1527	143	0.1916	172	0.2304	201	0.2693	230	0.3082	259	0.3470	288	0.3859
86	0.1156	115	0.1541	144	0.1920	173	0.2318	202	0.2706	231	0.3095	260	0.3484	289	0.3872
87	0.1165	116	0.1554	145	0.1943	174	0.2331	203	0.2720	232	0.3108	261	0.3497	290	0.3886
88	0.1176	117	0.1567	146	0.1956	175	0.2345	204	0.2730	233	0.3122	262	0.3510	291	0.3899
89	0.1192	118	0.1581	147	0.1969	176	0.2352	205	0.2747	234	0.3135	263	0.3524	292	0.3912
90	0.1206	119	0.1594	148	0.1983	177	0.2371	206	0.2760	235	0.3149	264	0.3537	293	0.3926
91	0.1219	120	0.1608	149	0.1996	178	0.2385	207	0.2773	236	0.3162	265	0.3551	294	0.3939
92	0.1232	121	0.1621	150	0.2010	179	0.2398	208	0.2784	237	0.3175	266	0.3564	295	0.3953
93	0.1246	122	0.1634	151	0.2023	180	0.2412	209	0.2800	238	0.3189	267	0.3577	296	0.3966
94	0.1259	123	0.1648	152	0.2036	181	0.2425	210	0.2814	239	0.3202	268	0.3590	297	0.3979
95	0.1273	124	0.1660	153	0.2050	182	0.2438	211	0.2827	240	0.3216	269	0.3604	298	0.3993
96	0.1286	125	0.1675	154	0.2063	183	0.2452	212	0.2840	241	0.3229	270	0.3618	299	0.4006
97	0.1299	126	0.1686	155	0.2077	184	0.2464	213	0.2854	242	0.3242	271	0.3631	300	0.4020
98	0.1311	127	0.1701	156	0.2088	185	0.2479	214	0.2867	243	0.3256	272	0.3644	301	0.4033
99	0.1326	128	0.1712	157	0.2103	186	0.2492	215	0.2881	244	0.3268	273	0.3658	302	0.4046
100	0.1340	129	0.1728	158	0.2117	187	0.2505	216	0.2894	245	0.3283	274	0.3671	303	0.4060
101	0.1353	130	0.1740	159	0.2130	188	0.2519	217	0.2907	246	0.3296	275	0.3685	304	0.4073
102	0.1366	131	0.1755	160	0.2144	189	0.2532	218	0.2921	247	0.3309	276	0.3696	305	0.4087
103	0.1380	132	0.1764	161	0.2157	190	0.2546	219	0.2934	248	0.3320	277	0.3711	306	0.4100

Machinery

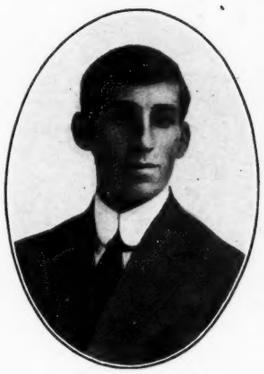
Volume IV of the transactions of the International Engineering Congress, which will be held in San Francisco, Cal., September 20-25 inclusive, 1915, will comprise an important series of papers on the general subject of railways and railway engineering. This field will be treated under seven principal topics covering relation of railways to social development; present status of railways; economic factors governing building of new lines; location; physical characteristics of road, including track and road-bed; bridges; tunnels; terminals; construction methods; signals; road equipment, including motive power other than electric; rolling stock in general; floating equipment; electric motive power in general. About twenty-seven papers are expected for this volume, which will be prepared by authors representing nine different countries. The transactions of the congress as a whole will include nine or ten other volumes, covering the various fields of engineering work.

* Address: Care of Detrick & Harvey Machine Co., Baltimore, Md.

PRODUCTION AND PREMIUM SYSTEM

USE OF DIFFERENT COLORED TAGS TO DISTINGUISH VARIOUS CLASSES OF ORDERS

BY A. J. SCHNEIDER*



A. J. Schneider†

THE following article, explaining the system used by the Cincinnati Planer Co., Oakley, Cincinnati, Ohio, should be of interest to many readers of MACHINERY. Production orders are divided into three distinct classes and a combination color scheme and order number system has been adopted to avoid confusion. The salmon color stock order, designated by the letter S, is issued for all standard details which can be manufactured and carried in stock, and order numbers in this class were started at 4000. The yellow lot L order is issued for one or more complete planers and calls for making all parts which are not carried in stock, and for all assembling, erecting and painting. Order numbers in this class were started at 1. The green job J order is issued for anything that cannot be done on a stock or lot order, *i.e.*, repair work, shop work, tools, jigs or any special work. Order numbers in this class were started at 1500.

The new piece number is assigned by the drafting-room, placed on the drawing and sent to the planning and routing department. Here, the master sheet shown in Fig. 1, which is 5 by 8 inches in size, is made out giving the routing that is to be followed, the premium allowed on each operation, the number of the shelf where the proper jig will be found, the machine on which the work is to be done, the proper speed and feed to use, and the numbers of the successive departments through which the work passes. This master sheet is made out on tracing paper and sent to the blueprint room where five prints are made from it. Of these, one copy goes to the planning and routing department to be filed, and another is sent to the superintendent's desk in the shop, where a printed "sticker" is placed over one end of it and the sheet is then ready to be used as a location record, as shown in Fig. 2. The purpose of this location record is to afford an immediate index of the exact location and method of finding all production orders which are in the shop. The columns on the "sticker" are kept up-to-date by the time-keeper, who stamps the date of completion of each operation as taken from the finished time card, after making the rounds of the shop. The three remaining blueprints from the master sheet are sent to the cost department and filed, awaiting an order. The original master sheet is used every morning by the cost department for the purpose of figuring the premium time cards.

When an order for one or more pieces is received, two blueprints of the master sheet are taken from the cost department's file and the spaces at the top are filled out with the order number, quantity and date wanted, after which they are sent to the stock room to be filed until the raw material for the order is at hand. A colored "sticker" and double wire are then attached to one print as shown in Fig. 3, thereby making a tag of it. The stickers used for attaching the wire are salmon colored for stock orders, yellow for lot orders and green for job orders, thus indicating the class of order that is being dealt with. The second blueprint which was filled out and sent to the stock room is known as the foreman's order. This order, together with the blueprint which has been converted into a tag, and the necessary material for filling the order, are sent to the department where the first operation is to be performed. Each foreman has a file at his desk for filing the orders for work which is in process in his department. As soon as an operation is completed and the "date sent forward" has been stamped on the order by the foreman, the material, order and tag are transferred to the next department. The last operation on all tags calls for the finished material to be delivered to the stock room, and when this is done the stock-keeper puts his O. K. on the order and it is then returned to the cost department. The return of the order thus serves as a notice to the cost department that the order has been completed so that the cost may be figured.

ORDER NO. | QUANTITY | DATE WANTED | Group / Piece } 5043

RAIL –
48" X 48" – 30" V –
DRG. NO. 7224 –

OPERATION	PREMIUM Operation	Set up	Jig Shelf	MACHINE	Feed	Sp'd	DEPT.	DATE SENT FORWARD
Raw Stock							4	
1 Rgh. Plane F & S	8.30			7-10-37.			10	
2 CC	4.40						15	
3 Plane B & E	9.30		252	3-5.			10	
4 Fin plane F & S	8.30			7-10-37.			10	
5 Drill & tap back	1.55	3e		172-174.			13	
6 Bore ends & clamp	4.35	45	199 200	180 -			13	
7 Scrape	26.						16	
8 Paint							15	
9 Polish & chip O.G.	4.10						16	
10 Finished Stock							5	
1875. #cast iron –							gs	

COST DEPT. APR 24 1914

Fig. 1. Master Sheet which gives Detailed Information in regard to handling Each Order

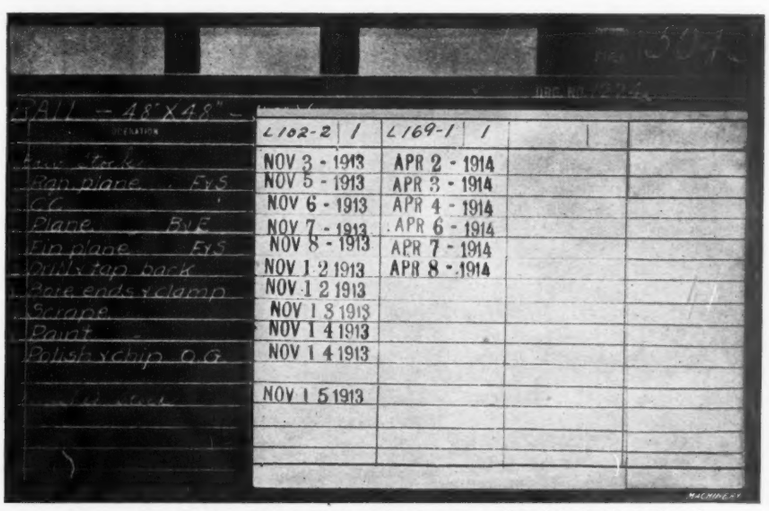


Fig. 2. Blueprint from Master Sheet, which is sent to Superintendent's Desk and provided with "Sticker" for Use in maintaining Location Record

* Address: Care of Cincinnati Planer Co., Cincinnati, Ohio.

† A. J. Schneider was born in 1886. He received a high school education and special courses in bookkeeping and corporation accounting. He has worked for the Wirthlin Bros., American Fire Engine Co., J. H. Day Co., Bullock Electric Mfg. Co., and Cincinnati Planer Co. His specialty is cost accounting.

The half premium plan of paying labor is employed in the plant of the Cincinnati Planer Co. Under this plan, the employe is given a guaranteed hourly rate and will automatically increase his wages in proportion to his ability. All premium pay earned is held back one week in order to afford time for the inspection of the work. The time card shown in Fig. 4, which is 4 by 6 inches in size, is made out by the time-keeper when a man starts work on a new job, information for this purpose being obtained from the tag shown in Fig. 3, which is always attached to the work. Referring to Fig. 4, it will be seen that the time-keeper made out this card at 4 P. M. on Thursday and closed it at 12 o'clock on Friday, when the

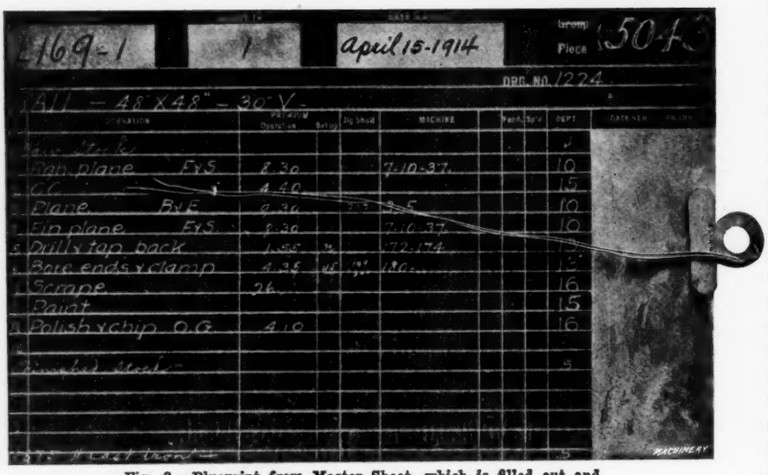


Fig. 3. Blueprint from Master Sheet, which is filled out and sent to Stock Room to be used as Tag

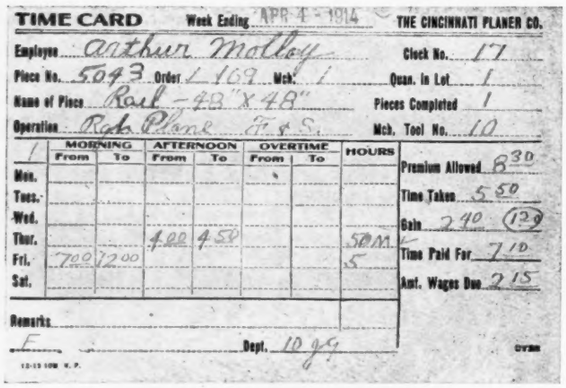


Fig. 4. Form of Time Card used

operation was finished and the workman was ready for his next job. It will be noticed that the premium allowance on this job was 8½ hours and the time taken was 5 hours and 50 minutes, showing a gain of 2 hours and 40 minutes. One-half of this premium is paid to the workman as a reward for the extra effort, in addition to the guaranteed hourly rate.

The purpose of the time variation sheet shown in Fig. 5 is to give immediate notice of any variation or irregularity in the time taken on an operation. This exposes everything which is abnormal, and will "show up" the incapable employe, foreman, or time-keeper; or the purchasing department in cases where the castings or bar stock was defective, or where the tools gave poor service. These sheets are made out every morning by the cost department, while the premium

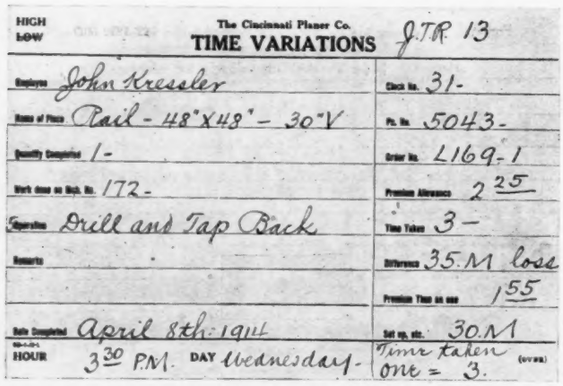


Fig. 5. Time Variation Sheet which shows Irregularities in Time taken on Any Operation

time cards are being checked; and in cases where the time taken is higher than the premium allowance or when it is one-half or less than one-half of the premium allowance, the time variation sheet is at once sent to the foreman who gives an explanation of the cause on the form provided on the back of this sheet, as shown in Fig. 6. The sheet is then sent to the superintendent, the purchasing department and finally to the cost department, where it is filed. A correct premium allowance and efficient organization call for sending out very few of these time variation sheets. Fully 95 per cent of the clerical work of this system is done in the office, where it can be handled to the best advantage, without hindering the shop work.

* * *

NON-RUSTING OR STAINLESS STEEL

The fact was lately mentioned in a consular report from Sheffield, England, that a firm in that city had introduced a steel which is claimed to be non-rusting, unstainable and untarnishable. The steel is especially adapted for table cutlery, as the original polish is maintained after use, even when brought in contact with most acid foods. It is an interesting fact that the steel was not made with a view to producing cutlery, however. The investigator was endeavoring to produce a steel for pump rods used in collieries, where a damp atmosphere had to be resisted. The application of the steel to cutlery was but a natural sequence, and no doubt a multitude of other uses will be found for it. In a tempered condition, the steel has a maximum strength of 50 to 55 tons per

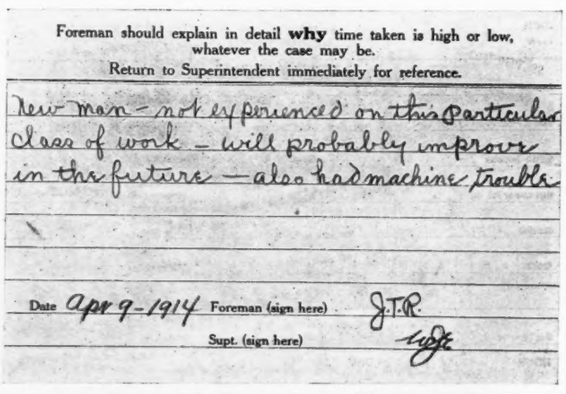

Foreman should explain in detail why time taken is high or low, whatever the case may be.
Return to Superintendent immediately for reference.
New man - not experienced on this particular class of work - will probably improve in the future - also had machine trouble
Date Apr 9-1914 Foreman (sign here) J.T.R.
Supt. (sign here)

Fig. 6. Form used by Foremen in explaining Irregularities in Time on Operations in Their Department

square inch, an elongation of 20 per cent, and a reduction of area approaching 60 per cent. In the hardened condition, the tensile strength is raised to about 100 tons. It is claimed that the steel retains a keen edge, much the same as the best double-shear steel.

The Firth-Sterling Steel Co., McKeesport, Pa., recently concluded an arrangement with Messrs. Thos. Firth & Son, Ltd., of Sheffield, whereby it will manufacture this "stainless" steel for the American market. Obviously there are many situations where a non-tarnishable steel would be much more satisfactory than the present steels.

* * *

The growth of the automobile industry is to some extent indicated by the growth of the Society of Automobile Engineers. At the end of 1912 this society had a membership of 1252; at the end of 1913, 1611; and at the end of 1914, 1804.

TURRET INDEXING MECHANISMS

CONSTRUCTION AND OPERATION OF DIFFERENT TYPES OF INDEXING MECHANISMS AS APPLIED TO MODERN MACHINE TOOLS

BY ALBERT A. DOWD*

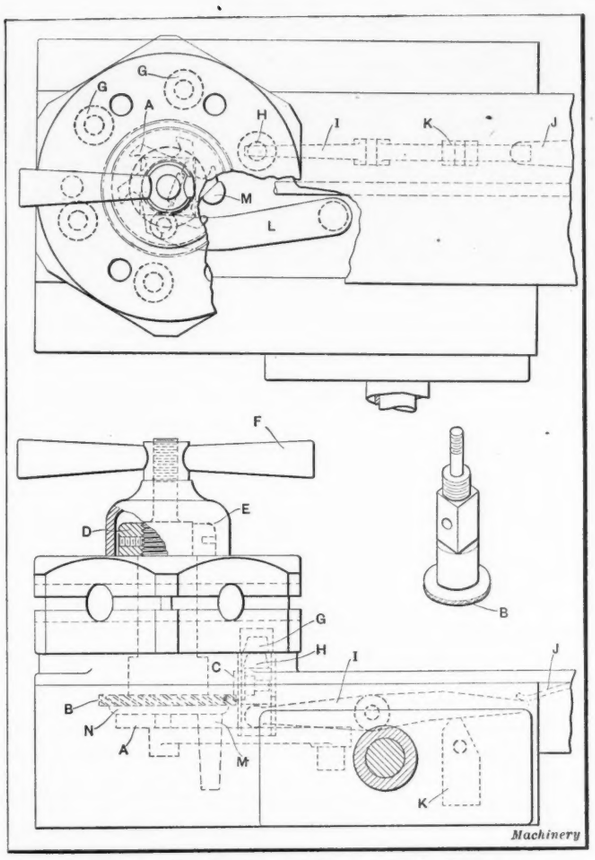


Fig. 1. Side Elevation and Plan of Garvin Turret

INDEXING mechanisms of various kinds may be used on nearly every variety of machine tool, but with the exception of the planer or shaper, the milling machine or gear-cutter and horizontal and vertical turret lathes, their application is of rare occurrence. When an indexing device is applied to a planer or shaper, it is usually a special fixture which may be used for holding a piece of cylindrical work to be grooved or serrated in a longitudinal direction. Sometimes the indexing or dividing head is used for cases of this kind, but it is obvious that when this is done the operator's careful attention is required at all times during the progress of the work, and it is necessary to stop the machine frequently while the indexing is being done. When a special fixture is used, however, it is possible to perform the indexing automatically by means of a projecting block which can be so arranged that it will push over a pawl at the end of the stroke, thus indexing the fixture. As the use of special indexing mechanisms on these machines is somewhat rare, it is not necessary to discuss the matter in this article.

The indexing mechanism of a gear-cutter is so simple that it does not require description, and it is further so well known that everyone is familiar with its action.

Applications to the milling machine are of frequent occurrence in the use of the index head, with which every toolmaker is familiar. This machine, however, is frequently furnished with special fixtures for a variety of work, the indexing being done by hand after each cut has been completed. Sometimes a hand milling machine is used, and when this is the case it is easily possible to so arrange it as to make the indexing automatic. Several years ago the writer designed and built a fixture for cutting the ratchet teeth on an automobile finger lever sector, the machine to which it was applied being a hand milling machine. In this instance both the feed and the indexing were accomplished automatically, and the cost of rigging up the machine was not great. A small special countershaft running at slow speed was hung above the machine and an overhanging end of the shaft was furnished with a disk. The face of the disk had a T-slot cut diametrically across it, which contained a shouldered T-bolt acting as a support for a long rod whose lower end was connected to the feed lever handle of the machine. An angular block was attached to the bed of the machine close to the table and this performed the indexing as the table moved back after each cut. The action took place through a roller on the end of a lever, to the other end of which a pawl was attached engaging with teeth on the revolving portion of the fixture. It was a very simple arrangement but one which gave excellent results. Adaptations of this were afterward made for two other jobs.

On turret lathes the highest development of indexing mechanisms is shown in the turret arrangements, because of the great demand for these machines and the necessity for rapid and accurate indexing. The requirements have been very carefully studied and have been developed year after year with a view to making the mechanisms as nearly perfect as possible. Accuracy has been the goal for which all the designers have striven and every known refinement has been employed to attain this end. In order to insure accuracy it is not sufficient to have the locating points or surfaces properly located when the machine is first built. The upkeep and proper provision for adjustments for wear must be carefully looked after and abuse must be considered as a large factor. In addition to this, the entrance of dirt or foreign matter of any kind must be carefully guarded against so that faulty indexing cannot be caused by imperfect contact of the locating points. It is evident that any variation at the locating points will be multiplied greatly at the end of a long boring-bar, so it is readily seen why so much care is necessary to secure accuracy in the indexing. Another point which has received a great deal of careful consideration is that of firmly clamping the turret after it has been indexed, so that no vibration will be apparent in the cutting tools due to a lack of rigidity in the turret. The arrangement for

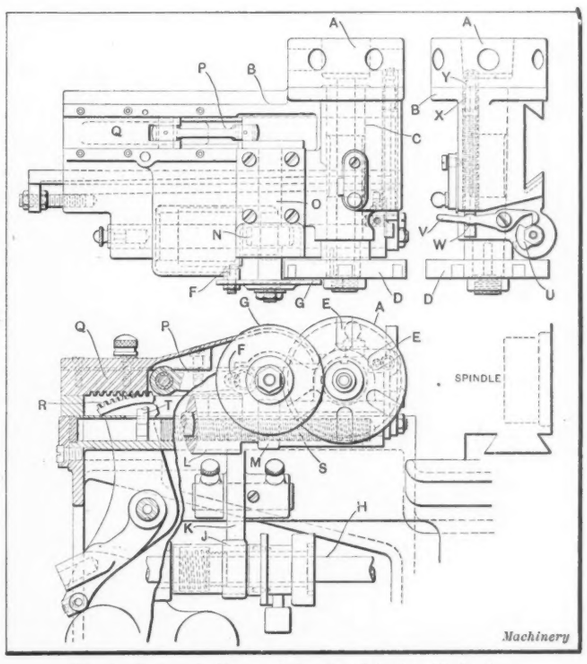


Fig. 2. Brown & Sharpe Automatic Indexing Mechanism

* Address: 221 Grove St., Bridgeport, Conn.

revolving the turret is subject to a great deal of abuse and it must therefore be of sufficient strength to withstand the maximum strains which may be put upon it without danger to the parts involved. We shall now consider several varieties of indexing mechanisms for the horizontal type of turret lathe.

Indexing Mechanism for the Garvin Turret Lathe

Fig. 1 shows a side view and plan of the turret and slide used on the Garvin turret lathe. The turret mounting is somewhat exceptional in that a square post is used as a driver (see perspective detail above the side elevation in the illustration) and the star wheel *A* is integral with it. This construction prevents any chance for lost motion between the turret and the star wheel and avoids all troubles which might be caused by parts jarring loose, due to the constant shock of indexing the turret. The stud itself is of steel and is hardened and ground to an accurate fit in the turret. It will be noted also that the individual stop shaft wheel *B* is a part of the same piece of steel, and controls the action of the stops by means of the spiral gear *C*. The turret is held in position by the collar *D* which is threaded onto the shank and is secured by a headless set-screw. A binding collar *E* clamps the turret down on the slide when the handle *F* is tightened. The lock pin bushings *G* on this turret are off at at one side of the center (see plan view), and the lock pin *H* is slotted at its lower end to receive the end of the lock pin lever *I* which is rounded on the end. The action of the spring *J* is self-evident. The tumbler *K* is the means by which the lock pin lever is operated, and its action will be described later. The turret rotator lever *L* is shown in the plan view, and carries at its forward end a hardened pin which engages with the star wheel.

The operation of the mechanism is as follows: As the turret slide is pulled back on the return stroke, the lock pin lever *I* rides up on the tumbler *K* and pulls out the lock pin *H* from the lock pin bushing *G*, in the under side of the turret. Just as this action is completed the star wheel *A* reaches a position where it engages the star wheel lever *L*. As the backward movement continues, the star wheel is turned around one division and the combined movements bring one of the star wheel teeth up against the stop-pin *M*. This takes the shock of the momentum and prevents any further movement. While this has been taking place, the under side of the lever *I* has been sliding along over the top of the tumbler *K*.

On the beginning of the forward stroke, the drag of the lever tips over the tumbler *K*, and the lock pin shoots into place as it is forced to do by the flat spring *J*. This arrangement prevents all rubbing of the pin against the under side of the turret while indexing from one position to another, and it will be further noted that the turret has been previously indexed to the correct position to receive this pin so that all wear on the end of the lock pin and lock bushing is avoided. The star wheel is shrouded by a flange *N* which also serves to hold the turret down.

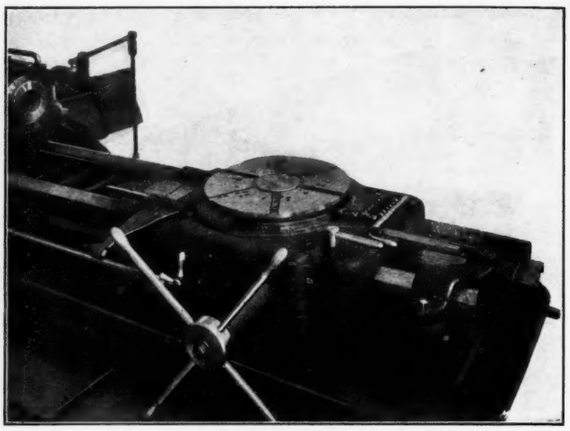


Fig. 4. Turret of Hartness Flat Turret Lathe

Steinle Turret Mechanism

The Steinle turret lathe is one of the heavier types, the turret being 20 inches in diameter and fitted with arrangements for carrying heavy tool equipment. A longitudinal section through the turret and slide and a transverse section and end view are shown in Fig. 3. It will be noted that the turret is fitted both on the bevel *A* (which makes it self-centering), and on the wide surface *B* as well, while it also has a supplementary central pin *C* which extends down through the slide and is held in place by a nut on the under side. The large adjusting nut *D* is screwed to the turret ring and acts as a thrust collar against which the binding ring makes up. The stop-operating ring *E* is cut in the form of a progressive cam on its lower side and controls the sector lever *F* which, in turn, revolves the stop rod *G*. A collar *H* is fixed to the end of this rod and the stops are held in place in any desired position by means of set-screws. The adjustable abutment for the stops is shown at *I*. The under side of the turret is fitted with taper bushings in which the taper locating pin *J* seats itself. Attention is called to the fact that this pin is 8⅝ inches from the center of the turret and this assists greatly in giving accurate turret locations. The pin is operated in one direction by the spring and in the other by the segmental wedge shaped block *K*. The supper surface of the clamping ring *L* is cut in the form of a three-point cam having a shallow rise, and the under side of the turret slide is cut to correspond. An extremely powerful clamping action of the turret is therefore attained by means of the lever *M*. It will be readily seen that as this lever is forced over by the hand of the operator, the cams work against each other and the turret is drawn down on the slide in such a way that the two form practically a solid unit. Provision is made for lubricating the moving surfaces by an oil-well and roller.

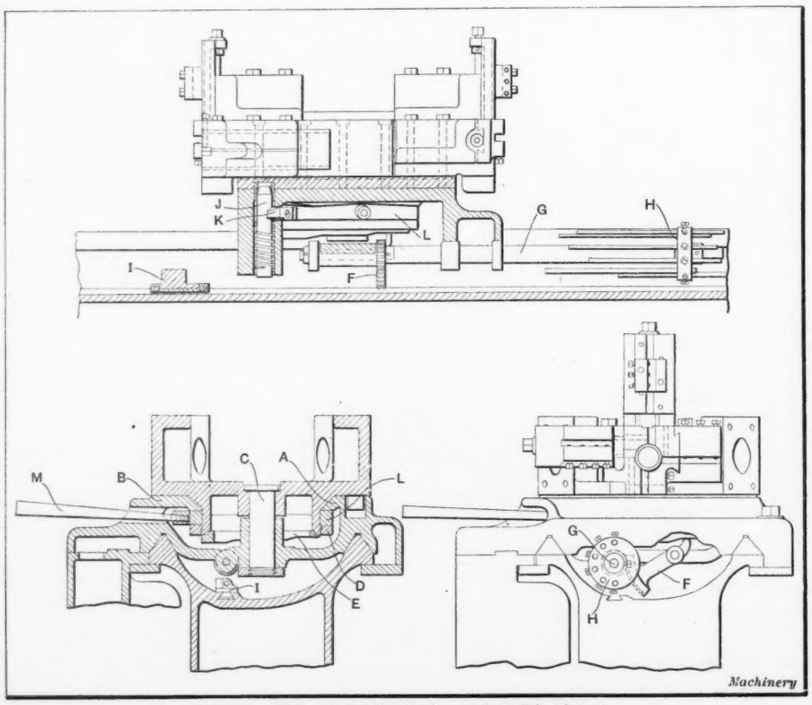


Fig. 3. End and Sectional Views of Steinle Turret

Brown & Sharpe Automatic Index Mechanism

We now come to an entirely different arrangement, in that the machine itself is of the automatic type and therefore all

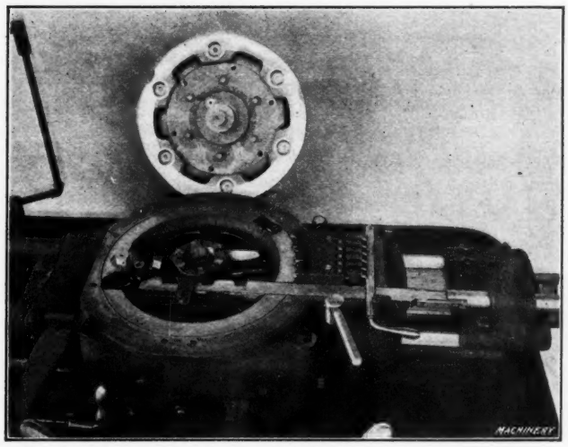


Fig. 5. Hartness Flat Turret raised from Seat to expose Mechanism

indexing movements must be performed automatically. The upper view in Fig. 2 shows the turret *A* mounted on the slide *B*. The turret itself is of steel and is made with a cylindrical shank *C* which passes through the bearing and is fitted on the other end with the index plate *D*. This plate has six slots *E* on its outer surface, these being spaced 60 degrees apart. A roller *F* is secured to the back face of the disk *G* in such a position that it will engage with the slots *E* as the disk is revolved. The feed shaft *H* (shown in the lower view) is at the rear of the machine and operates the train of gears *J*, *K*, *L*, *M*, the last of which is a spiral gear meshing with the gear *N* (upper view) on the shaft *O*. An intermittent clutch on the feed shaft is thrown into engagement at the proper time by means of a trip lever operated by a cam. (This is not shown in the illustration.) On the other end of the shaft *O* the crank *P* is pivoted. Its other end is connected to the block *Q*, which is free to move independently of the slide itself except when restrained by the crank's locking action when in the position shown. The sector *R* carries the turret forward by the action of the cam that controls it. The coil spring *S* forces the turret slide back after a machining operation has been performed. The pin *T* is fixed in the slide and the spring acts against it through the medium of an annular grooved plunger, the groove engaging with the pin. The upper end of the pin is shown broken away.

The turret itself is fitted with taper bushings *Y* in which the end of the index pin *X* locates. The action of the latter is controlled by the cam *U* and the coil spring shown. This cam is on the end of the shaft that contains the spiral gear operating the indexing mechanism. It will be noted that the lever *V* works in a slot *W* in the side of the bolt. The action of the mechanism is as follows: At the completion of an operation the trip mechanism throws in the intermittent clutch on the feed shaft. This motion is transferred through the train of gears to the index disk *G*, which starts to revolve and pulls the crank *P* forward as it rotates, thus allowing this spring *S* to gradually force the turret slide back and thereby remove the tool from the work. The cam *U* now operates the lever and pulls out the lock bolt, immediately after which the roller *F* has reached a point where it engages with one of the slots *E*, and as it continues to revolve the turret is rapidly indexed. At the proper time (the cam having released the lever) the lock bolt snaps into place but the crank continues to move until it reaches the position shown in the illustration, at which time the intermittent clutch is thrown out of engagement, thereby leaving the whole slide tied together through the medium of the link. The turret is now carried forward by the toothed sector *R* for the next operation, the sector engaging a rack affixed to the turret slide.

It will be noted that the link motion and floating action between the block *Q* and the slide, is of great value, in that it permits the withdrawal of the tools from the work just as soon as the end of the stroke is reached without waiting for the roll to drop off the end of the cam. The result is a considerable saving in time over other methods.

Hartness Flat Turret Lathe Indexing Mechanism

Fig. 4 shows the turret of a Hartness flat turret lathe, with a portion of the annular gib removed to show the construction. Fig. 5 shows the turret tipped up and the internal mechanism exposed to view. Fig. 6 (upper view) is an isometric drawing of the turret and slide, broken away to show the construction, while the lower view is a plan.

The turret construction, indexing mechanism, and system of stops for this machine show many novel features which are well worth studying. Figs. 4 and 5 show the general appearance of the turret and slide, and attention is especially directed to the clean appearance of the design as a whole and the freedom from dirt- and chip-catching projections. The accessibility of the various levers is also an important feature. Referring to Fig. 6, the turret itself is of cast iron and is located on a central steel stud *A* and gibbed down by four annular gibs around its periphery. A ratchet gear *B* engages with the spring ratchet pin *C* and is used to revolve the turret (see small section in upper left-hand corner of illustration). The turret turning rack-bar *D* is of rectangular section and has at its forward end three notches which engage with teeth in the ratchet gear. The spring taper locating pin *E* is set well out from the center of the turret and directly underneath the cutting tool. This insures great accuracy. The upper end of the pin enters one of the hardened bushings in the under side of the turret. The pin itself is also carried in a bushing and a coil spring underneath forces it into place. The locking pin lever *F* pivots on the pin *G* and is controlled by the rocker *H* which is fastened to it. The latch *I* (see section *Y-Y*) keeps the lock pin lever down while the turret is being indexed, and the screws *J* trip it and allow the lock pin to swing into place at the termination of the indexing movement. An oiling roll *K* furnishes lubrication for the turret. The lever *L* locks the slide firmly in any desired position on the ways.

The stop mechanism on this machine is very efficient and

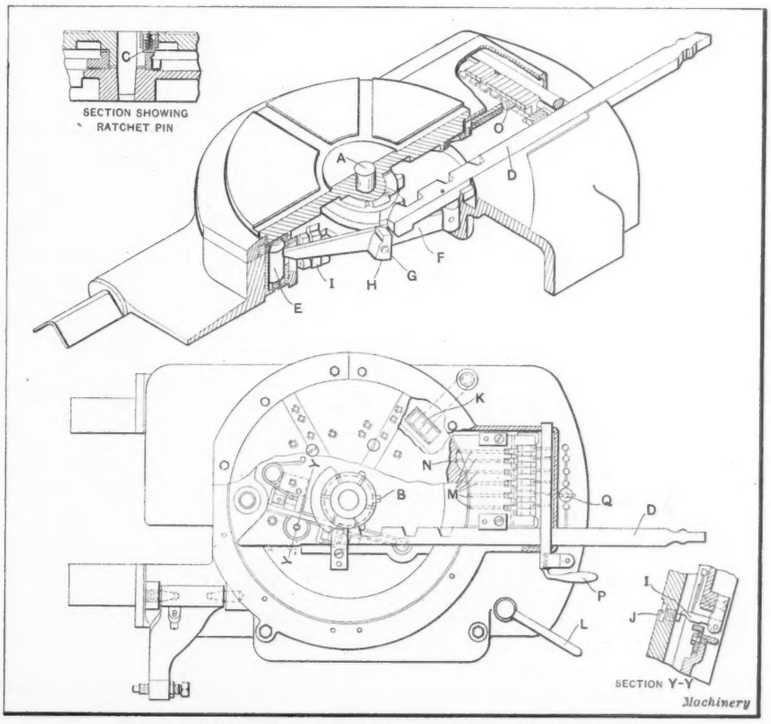


Fig. 6. Indexing and Stop Mechanism of Hartness Flat Turret Lathe

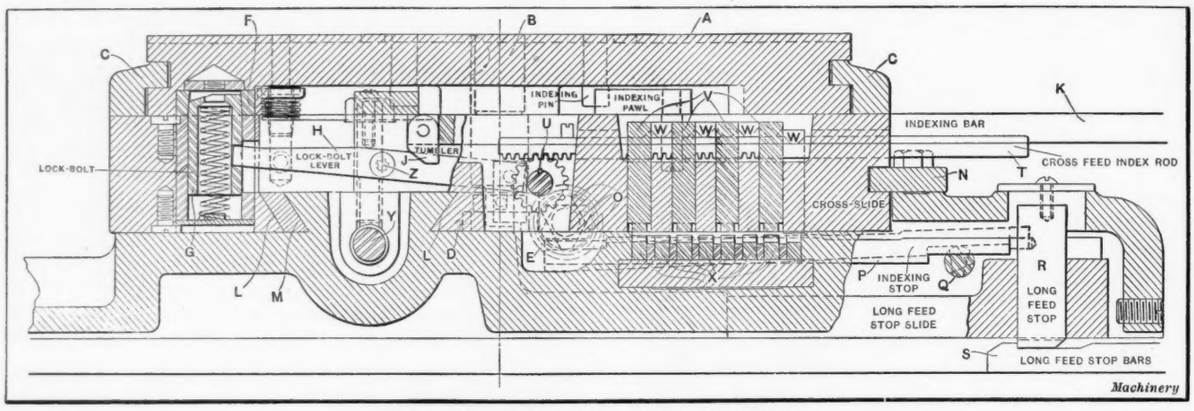


Fig. 7. Longitudinal Section of Acme Flat Turret

quite unusual, there being twelve stops in all—two for each position of the turret. The main stop bars are of rectangular section and about four feet long; they lie directly under the carriage saddle and are snugly nested together in the top of the bed casting. Each bar has a notch cut in it on its upper edge and this notch is square on the front end but beveled on the rear. Into these notches the supplementary bolts in the turret drop, thereby arresting the forward movement of the slide. The supplementary bolts are nested in a vertical pocket in the carriage, and are controlled by the turret through the medium of the tappet rods shown at *M* in the plan view. These tappet rods snap into the semicircular pockets in the turret at *N* and make contact with six small lifting cranks *O* which hold the vertical stop bolts out of engagement except when the tappet rod enters the pocket. The bolt for this particular rod is then allowed to drop below the others, and therefore as the turret slide moves forward, it engages the notch in the lower bar and arrests the forward motion of the slide. In this connection it is well to note that a slip mechanism is provided on the turret feed so that it does not spring back after coming to the stop but remains there until moved back by the operator. In coming up to a shoulder it will be seen that this "dwell" serves to smooth up the shoulder. The lever *P* is so arranged that either half of the stops may be lifted at one time, or alternate stops, and by turning the lever to a central position, all of the stops may be lifted out of engagement.

By placing an auxiliary stop pin *Q* in any one of the six holes shown, it is possible to secure an extra stop position by inserting the pin in one of the holes not in use on that particular job. In fact, seven longitudinal positions of the turret may be obtained by using the regular stop for one position and the alternate six extra stops for the remainder. A more adaptable arrangement would be hard to find.

In operating the index mechanism after a turning or boring operation has been completed, the turret is run back until the back stop is struck by the turret turning rack bar, and as the retrograde movement continues, this bar slides over the rocker *H* and depresses the lever, thereby pulling out the turret locking pin; the latch *I* snaps over the lever and holds it down. The notches in the bar now engage with the ratchet gear and revolve the turret until the end of the trip screw *J* disengages the latch *I*. This releases the locking pin lever *F* which permits the turret locking pin to spring up into position, thereby positively locating the turret. A valuable feature of this design is that any one of the trip screws can be screwed up so that the turret can be indexed past any position not needed, thus saving time.

When the indexing takes place, the tappet rod corresponding to the turret face in use snaps into the semicircular pocket *N* in the turret and allows the proper stop bar to drop down to its correct position. As the turret slide is run forward again, the bar *D* is held at the rear by the spring fingers on the back stop (see also Fig. 4), with sufficient pressure to pull back the ratchet gear to its normal position.

Bullard and Pratt & Whitney Indexing Mechanisms

On the Bullard vertical turret lathe the turret is at an angle to give more clearance when swinging tools over the slide. The indexing mechanism is hand actuated by means of a crank and pinion, after the turret has been drawn forward away from the locating pins. The action is simple and efficient, but does not require a lengthy description. The method of locating is, however, somewhat extraordinary. There is a double set of pins which are slabbed off on the sides to a shallow taper, and firmly fixed in the slide at the upper part of the turret bearing seat. On the back of the turret at each of the five turret positions another set of pins with opposing tapers is fixed, these being very carefully fitted so that the tapers make up snugly at the same time that the turret is drawn back onto its seat. The advantage derived from an indexing position that is away from the turret seat is that, as there

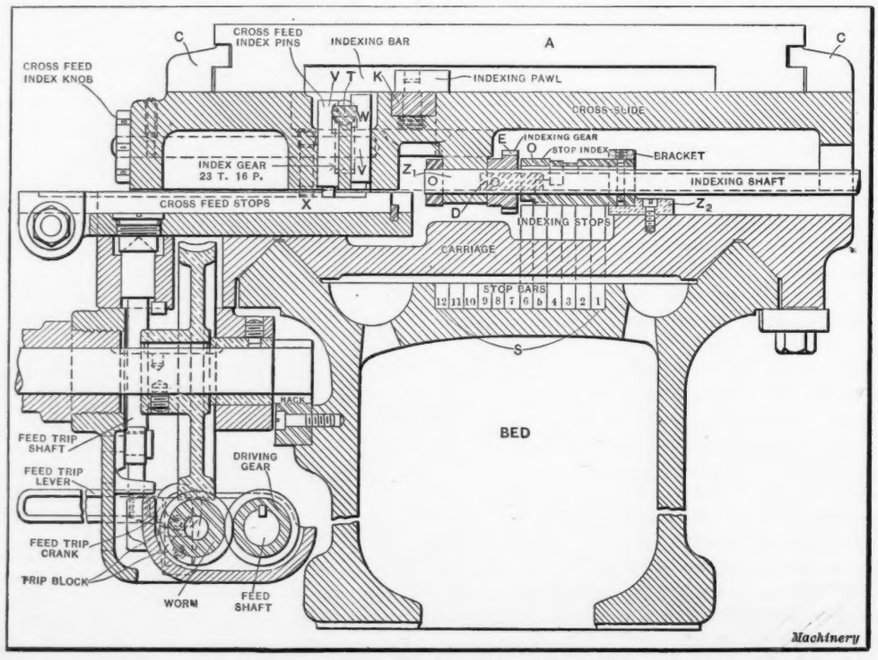


Fig. 8. Transverse Section of Acme Flat Turret

is no friction on the seat while indexing, there can be no wear, and alignment is therefore more absolute.

The new Pratt & Whitney side-head boring mill also uses a turret set on an angle. It is located on a large central stud but does not leave its seat when indexing. A hand lever connected by internal gearing is used to revolve the turret. Two lock bolts are used to locate this turret, these being wedge shaped on the ends to fit angular slots in the index ring, which is of large diameter, thus insuring great accuracy. All these working parts are hardened and ground to a fit. The lock bolts are supported on each side by taper gibs easily adjusted to take up wear. The mechanism is operated by a lever-controlled pinion which engages the rack portion of the bolts and forces them into their seats. This lever is also so arranged that it binds the turret securely to its seat on the slide, making practically a solid unit.

Acme Flat Turret Lathe Mechanism

This machine has a cross-sliding turret in addition to its regular longitudinal movement. Fig. 7 shows a longitudinal section through the turret, while Fig. 8 gives a transverse section. The turret *A* in Fig. 7 is centered by the plug *B* and is held down by the annular gibs *C*. As the slide is run back the indexing bar *K* strikes the stop arranged for that purpose on the ways of the machine. The bar moves forward in its relation to the turret until the tumbler *J* strikes the roll *Z* on the lock bolt lever *H*, depressing it and pulling over lock bolt *G*, after which the indexing pawl revolves the turret by means of the pins on its under side, and the lock bolt snaps into place in the tapered bushing *F*.

The cross-slide of the turret is of the dovetail type, as shown at *L*, and it is provided with adjustment in the gib *M*. The stops for the cross-slide are eight in number and are controlled by a knob at the front of the slide, which permits the revolution of the rod *U* on which a spur gear is mounted. This gear moves the cross-feed index rod in either direction and allows any of the stop pins *V* or *W* to drop into the angular slot in the rod. As the cross-slide is fed forward, the end of the pin which has dropped brings up against one of the stop rods *X* which are nested together in the base. It will be seen that any or all of the eight stops may be used for any one position of the turret, thus making possible a great range of stops for intricate shoulder work. Reference to Fig. 8 will make this construction perfectly clear. The longitudinal turret stops are twelve in number, six of these being controlled by the indexing of the turret while the other six are operated independently by a knob on the front of the turret slide.

As the turret is indexed, the spiral gear *D* on the turret center stud meshes with the gear *E*, causing it to revolve one-sixth of a turn. By referring to Fig. 8 it will be seen that the stop index *O* is slabbed off in six places and that the shaft which carries it has a bearing at Z_1 and Z_2. As the shaft revolves, the indexing stop levers are operated so that one of the longitudinal feed stops *R* (Fig. 7) is allowed to drop down below the rest so that it eventually brings up against the shoulder on the longitudinal feed stop bar *S*. These bars are nested in the bed as shown in Fig. 8 and they are protected from dirt and chips by the slide itself which covers them. As all the mechanism of the stops is internally located there is very little danger of inaccuracies resulting from imperfect contact due to dirt or chips.

The six independent stops for the turret longitudinal feed are operated by a knob at the front of the slide, which controls the rod *Q* that is flattened off in six places. Its operation is the same as the mechanically controlled stop index, except that it is controlled by hand and is so arranged that all six stops can be used for any one turret face, if desired, in addition to the regular stop. This makes possible the production of longitudinal shoulder distances with great accuracy.

Other designs of turret indexing mechanisms could be cited but they would do no more than elaborate the subject without serving any useful purpose. The examples given are as widely different as it was possible for the writer to select, no attempt being made to illustrate every turret mechanism on the market, as this would take too much space.

VERTICAL DRILLING OF DRILL ROD BILLETS

A new method of producing hollow steel bars used for rock drill rods was described in the October, 1914, number. It consists essentially of drilling a billet, filling the hole with a special composition, plugging the ends and then heating and rolling to the diameter of drill rod required. The composition with which the hole is filled elongates with the rolling but holds the circular shape. By this process, it is possible to produce, say, a ¾-inch drill rod 30 feet long with a ¼-inch axial hole extending from end to end. While the hole is not mathematically exact, it is sufficiently true to the axis and uniform in diameter to answer the purpose desired, which is to convey water to the point of the drill when drilling holes in stone. The water forcing out the chips and cooling the point of the drill, greatly increases the speed at which holes can be drilled.

The manufacture of this type of rock drill rod having been licensed in the United States by Dunford & Elliott, Ltd., Attercliffe Wharf, Sheffield, England, by whom it was originated, some interesting American machines have been designed for its manufacture. One of these, recently built by the Foote-Burt Co., Cleveland, Ohio, is an inverted drilling machine for drilling the billets. The method of forming the hole in the billet first employed by Dunford & Elliott was the well-known Mannesmann process by which a pointed mandrel is forced axially through the billet while being rolled hot with hyperboloidal rolls. This process was found to be objectionable because it caused minute radial cracks which later extended and caused failure of the drill rod.

The Foote-Burt drilling machine holds the square billet, about 5 by 5 inches and 20 inches long, in a frame mounted on a slide on the vertical face of the drill column, jaws being provided for centering it over the drill which stands beneath. With this machine, a 1¼-inch hole can be drilled in 90-point carbon steel 20 inches deep in 20 minutes, the feed being one inch per minute. Oil-tube drills with straight flutes or with flutes having less than half the usual angle with the drill axis are used.

The advantages claimed for the internal drilling machine are rigid support for the drill spindle because of being mounted in the base close to the floor, and the inverted position of the drill which permits chips to fall by gravity. The fact that the chips fall from the hole by gravity, the clearing being aided by the lubricant forced in under pressure, permits the use of a type of drill that breaks the chip instead of curling it. This reduces the heat generated and tends to produce more effective cutting.

The efficiency of inverted drilling in this case is indicated by the fact that 26 billets were drilled in ten hours, the hole in each being 20 inches deep and 1¼ inch in diameter. The peripheral speed of the drill used was 50 feet per minute and the feed, as stated, was one inch per minute or 0.0065 inch per revolution. In the foregoing it was stated that the billets drilled are 5 inches square, but the size depends on the diameter of the drill rod to be rolled, the diameter of hole required and the length to be rolled.

* * *

Piping of various kinds such as gas, water, steam-heating, vacuum cleaning or compressed air, is often concealed within walls, generally under plaster, and when it comes to making repairs or replacing such pipes, their exact position cannot always be found without doing considerable damage to the wall. A recently patented electric method for locating the pipes is simply a special application of the well-known induction balance principle. As described in the *Scientific American*, a convenient apparatus is made up of two sets of coils placed on the ends of a magnet bar. One set of coils receives alternating or vibratory current from a suitable source, and the other is connected to a telephone. The balance is first established so that no sound is heard in the telephone. When the device comes near the metal piping, this disturbs the balance and a sound is heard. It is thus an easy matter to find the exact position of the pipes and to reach them with less damage to the wall.

USE OF CONTINUED FRACTIONS IN MECHANICAL PROBLEMS*

THE THEORY OF CONTINUED FRACTIONS AND THEIR APPLICATION TO CHANGE GEAR PROBLEMS

BY WILLIAM W. JOHNSON†

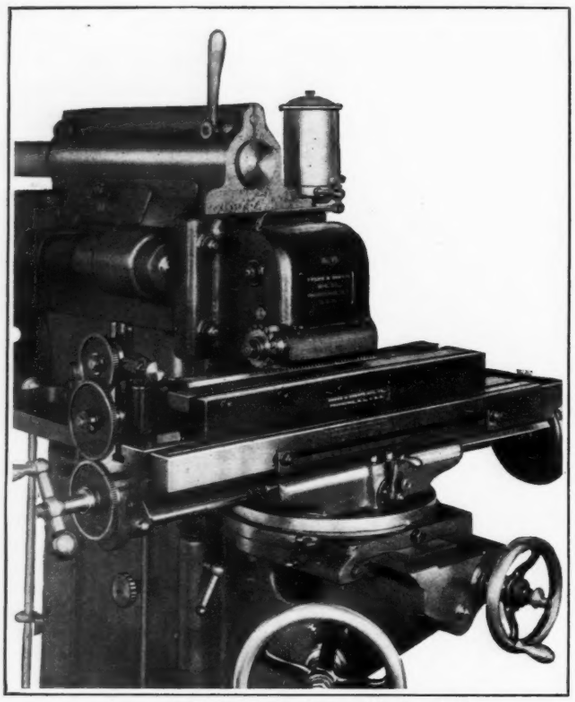


Fig. 1. Rack Cutting Indexing Attachment of Brown & Sharpe Milling Machine

QUITE often in the operation of machine tools, the problem arises of selecting the required change gears for handling some specific operation. A typical example of this kind is where the rack cutting indexing attachment is to be used to obtain some fractional spacing that is not given in the index table; and it is the purpose of this article to show by the solution of a few examples how accurate results can be obtained by employing continued fractions in selecting suitable change gears for the rack cutting indexing attachment of the Brown & Sharpe milling machine. This attachment is shown in Fig. 1 set up for milling a rack, accurate spacing being obtained by means of a locking disk connected to the feed-screw of the milling machine by two change gears and two equal gears, which connect the indexing attachment with the feed-screw. The ratio of the change gears determines the distance that the milling machine table moves for each turn of the locking disk. The change gears furnished with a Brown & Sharpe indexing attachment are two with 56 teeth and one each of 28, 35, 42, 44, 49, 63, 70, 77, 84, 88, 91, 98, 105 and 112 teeth. These gears will be referred to again in the examples which follow.

Before proceeding to work out an example we will consider briefly some of the properties of continued fractions which are useful in reducing fractions with large terms to approximate fractions with smaller terms. Any common fraction $\frac{N}{D}$ in its lowest terms may be converted into a simple terminating continued fraction of the form:

$$Q_1 + \cfrac{1}{Q_2 + \cfrac{1}{Q_3 + \cdots}}$$

The preceding form of fraction is commonly written:

$$Q_1 + \frac{1}{Q_2 +}\ \frac{1}{Q_3 + \cdots}$$

where Q_1, Q_2, Q_3, etc., are the successive quotients in the operation of finding the greatest common divisor of N and D.

When $\frac{N}{D}$ is a proper fraction the first quotient Q_1 is zero.

In the continued fraction $Q_1 + \frac{1}{Q_2 +}\ \frac{1}{Q_3 +}\ \frac{1}{Q_4 + \cdots}$ the fractions formed by taking one, two, etc., of the quotients are called "converging fractions," or the "principal convergents" to the continued fraction. Each convergent is nearer in value to the continued fraction than any preceding convergent. Let $\frac{N_1}{D_1}, \frac{N_2}{D_2}, \frac{N_3}{D_3}, \cdots \frac{N_n}{D_n}$ represent the successive convergents, which will be fractions in their lowest terms.

Then we have:

$$\text{1st convergent} = \frac{N_1}{D_1} = Q_1 \text{ or } \frac{Q_1}{1}; \qquad (1)$$

$$\text{2nd convergent} = \frac{N_2}{D_2} = Q_1 + \frac{1}{Q_2} = \frac{Q_2Q_1 + 1}{Q_2}; \qquad (2)$$

$$\text{3rd convergent} = \frac{N_3}{D_3} = Q_1 + \frac{1}{Q_2 +}\ \frac{1}{Q_3} = \frac{Q_3(Q_2Q_1 + 1) + Q_1}{Q_3Q_2 + 1} = \frac{Q_3N_2 + N_1}{Q_3D_2 + D_1} \text{ [from (1) and (2)]};$$

In general, we find:

$$\text{nth convergent} = \frac{N_n}{D_n} = \frac{Q_nN_{n-1} + N_{n-2}}{Q_nD_{n-1} + D_{n-2}} \qquad (3)$$

Formula (3) expresses the law of formation of the successive convergents to a continued fraction, each convergent after the second being obtained from the two convergents immediately preceding it. The last convergent is always equal to the common fraction from which the continued fraction is obtained; and any convergent that immediately precedes a large quotient is a near approximation to the value of the continued fraction.

Example 1

Suppose, for example, that a rack is required with a distance between adjacent teeth of 0.268 inch. Then we have the following:

$$\text{Ratio of change gears} = \frac{\text{pitch required}}{\text{lead of feed-screw}} = \frac{0.268}{0.250} = \frac{\text{number of teeth in gear on locking disk}}{\text{number of teeth in gear on feed-screw}} = \frac{134}{125}.$$

As we have no gears with so large a number of teeth, we will have to content ourselves with an approximation of this ratio. To obtain the best possible approximation we convert

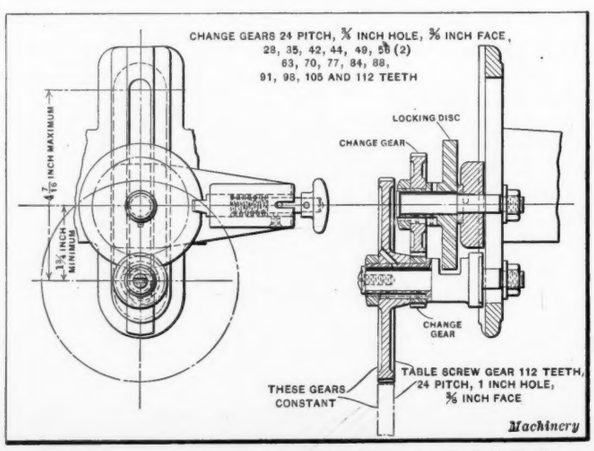

CHANGE GEARS 24 PITCH, ¾ INCH HOLE, ⅜ INCH FACE,
28, 35, 42, 44, 49, 56 (2)
63, 70, 77, 84, 88,
91, 98, 105 AND 112 TEETH
LOCKING DISC
CHANGE GEAR
CHANGE GEAR
THESE GEARS CONSTANT
TABLE SCREW GEAR 112 TEETH, 24 PITCH, 1 INCH HOLE, ⅜ INCH FACE
Machinery

Fig. 2. Diagram showing Arrangement of Gears on B. & S. Rack Cutting Indexing Attachment

* For other articles on this subject published in MACHINERY see "Selecting the Number of Teeth for Gears and Sprockets," by G. M. Bartlett, September, 1912; and "How to Obtain Approximate Fractions by the Method of Continued Fractions," by Mitchell Dawes, August, 1908.

† Address: 1218 Parkwood Drive, Cleveland, Ohio.

$\frac{134}{125}$ into a continued fraction and calculate the principal convergents as follows:

$$
\begin{array}{l}
125)134(1 = \text{1st quotient} = Q_1 \\
\quad 125 \\
\quad \overline{} \\
\quad 9)125(13 = \text{2nd quotient} = Q_2 \\
\quad\quad 117 \\
\quad\quad \overline{} \\
\quad\quad 8)9(1 = \text{3rd quotient} = Q_3 \\
\quad\quad\quad 8 \\
\quad\quad\quad \overline{} \\
\quad\quad\quad 1)8(8 = \text{4th quotient} = Q_4 \\
\quad\quad\quad\quad 8 \\
\quad\quad\quad\quad \overline{} \\
\quad\quad\quad\quad 0
\end{array}
$$

From the successive quotients just found we can calculate the principal convergents by means of Formulas (1), (2), (3), and arrange them for convenience in calculating, as shown in Table I. Since the third convergent precedes a large quotient we select $\frac{15}{14}$ as a near approximation to the value of the fraction $\frac{134}{125}$. Then:

TABLE I. VALUES OF PRINCIPAL CONVERGENTS OBTAINED IN SOLVING PROBLEM 1

Number of quotient = n	1	2	3	4
Quotient = Q	1	13	1	8
Numerator of convergent = N	1	14	15	134
Denominator of convergent = D	1	13	14	125

Machinery

$$\frac{\text{Number of teeth in gear on locking disk}}{\text{Number of teeth in gear on feed-screw}} = \frac{15 \times 7}{14 \times 7} = \frac{105}{98}.$$

Referring to the list of change gears we find that we have gears with 105 and 98 teeth. For checking to find the error resulting from the use of this approximation we have the formula:

$$\text{Distance work moves} = \frac{PLT}{S} \qquad (4)$$

where P = number of teeth in gear on locking disk stud;
L = lead of feed-screw (¼ inch on B. & S. milling machine);
T = number of turns of locking disk;
S = number of teeth in first gear on stud (connected directly to feed-screw by means of equal gears).

The sum of the number of teeth P and S should be not greater than 213; nor less than 84, due to the maximum and minimum gear centers on the B. & S. indexing attachment. For the B. & S. milling machine, Formula (4) becomes:

$$\text{Distance work moves} = \frac{TP}{4S} \qquad (5)$$

Example 2

Given a rack with a pitch of 0.2585 inch, to find the necessary change gears:

$$\text{Ratio of change gears} = \frac{0.2585}{0.2500} = \frac{517}{500}.$$

We will again try, by employing continued fractions, to find a fraction that will enable us to use the gears at hand. Calculating the principal convergents as before, we have:

$$
\begin{array}{l}
500)517(1 = Q_1 \\
\quad 500 \\
\quad \overline{} \\
\quad 17)500(29 = Q_2 \\
\quad\quad 493 \\
\quad\quad \overline{} \\
\quad\quad 7)17(2 = Q_3 \\
\quad\quad\quad 14 \\
\quad\quad\quad \overline{} \\
\quad\quad\quad 3)7(2 = Q_4 \\
\quad\quad\quad\quad 6 \\
\quad\quad\quad\quad \overline{} \\
\quad\quad\quad\quad 1)3(3 = Q_5 \\
\quad\quad\quad\quad\quad 3 \\
\quad\quad\quad\quad\quad \overline{} \\
\quad\quad\quad\quad\quad 0
\end{array}
$$

TABLE II. VALUES OF PRINCIPAL CONVERGENTS OBTAINED IN SOLVING PROBLEM 2

Number of quotient = n	1	2	3	4	5
Quotient = Q	1	29	2	2	3
Numerator of convergent = N	1	30	61	152	517
Denominator of convergent = D	1	29	59	147	500

Machinery

It would appear that the method of continued fractions fails to give a suitable ratio in this case. We may, however, find another series of convergents, intermediate between any two principal convergents, if the quotient Q_n from which the last one of the two principal convergents was derived is greater than 1. The number by which this quotient exceeds 1 will be the number of intermediate convergents we can find between any two consecutive principal convergents. In the present case, we can find one more convergent between $\frac{N_3}{D_3} = \frac{61}{59}$ and $\frac{N_4}{D_4} = \frac{152}{147}$, because $Q_4 = 2$, which is one in excess of 1. The intermediate convergents between Q_n and Q_{n-1} are found by the formula:

$$\frac{N_{n-2} + kN_{n-1}}{D_{n-2} + kD_{n-1}}. \qquad (6)$$

where k is given successively the values 1, 2, 3 .....Q_n.

TABLE III. VALUES OF INTERMEDIATE CONVERGENTS OBTAINED IN SOLVING PROBLEM 2

Multiplier k			1	2
Numerator of convergent = N	30	61	91	152
Denominator of convergent = D	29	59	88	147

Machinery

For convenience in calculating intermediate convergents, we arrange the work as shown in Table III. We find we have gears for the ratio $\frac{91}{88}$; and computing the error obtained by using these gears, we have by Formula (5):

$$\text{Distance work moves} = \frac{1 \times 91}{4 \times 88} = 0.25852 \text{ inch.}$$

This is a very close approximation to the required pitch and allows us to use the regular gears.

Example 3

Given the problem of setting up the machine to cut a rack with a pitch of 0.479 inch, to find the necessary change gears. Using the method of calculation already employed, we get:

$$
\begin{array}{l}
250)479(1 = Q_1 \\
\quad 250 \\
\quad \overline{} \\
\quad 229)250(1 = Q_2 \\
\quad\quad 229 \\
\quad\quad \overline{} \\
\quad\quad 21)229(10 = Q_3 \\
\quad\quad\quad 210 \\
\quad\quad\quad \overline{} \\
\quad\quad\quad 19)21(1 = Q_4 \\
\quad\quad\quad\quad 19 \\
\quad\quad\quad\quad \overline{} \\
\quad\quad\quad\quad 2)19(9 = Q_5 \\
\quad\quad\quad\quad\quad 18 \\
\quad\quad\quad\quad\quad \overline{} \\
\quad\quad\quad\quad\quad 1)2(2 = Q_6 \\
\quad\quad\quad\quad\quad\quad 2 \\
\quad\quad\quad\quad\quad\quad \overline{} \\
\quad\quad\quad\quad\quad\quad 0
\end{array}
$$

TABLE IV. VALUES OF PRINCIPAL CONVERGENTS OBTAINED IN SOLVING PROBLEM 3

Number of quotient = n	1	2	3	4	5	6
Quotient = Q	1	1	10	1	9	2
Numerator of convergent = N	1	2	21	23	228	479
Denominator of convergent = D	1	1	11	12	119	250

Machinery

We have gears for the ratio $\frac{21}{11} = \frac{84}{44}$.

$$\text{Distance work moves} = \frac{1 \times 84}{4 \times 44} = 0.47727 \text{ inch.}$$

The use of these gears introduces an error of 0.0017 inch. If we need a closer approximation, we will again try to find a suitable ratio by calculating the intermediate convergents between $\frac{23}{12}$ and $\frac{228}{119}$. In making this calculation, we have the values presented in Table V. Either of the ratios $\frac{44}{23}$, $\frac{67}{35}$,

TABLE V. VALUES OF INTERMEDIATE CONVERGENTS OBTAINED IN SOLVING PROBLEM 3

k			1	2	3	4	5	6	7	8	9
Numerator of convergent = N	21	23	44	67	90	113	136	159	182	205	228
Denominator of convergent = D	11	12	23	35	47	59	71	83	95	107	119

Machinery

and $\frac{182}{95}$ would give a close approximation, but each would require one special gear. Selecting $\frac{182}{95}$ as the nearest approximation, we have, making $T = 2$ in Formula (5):

$$\text{Distance work moves} = \frac{2 \times 91}{4 \times 95} = 0.47894 \text{ inch.}$$

This would require a special gear with 95 teeth, and two turns of the locking disk. The preceding method of finding one or more series of fractions intermediate between two principal convergents is quite simple, and often it is the only solution for obtaining a suitable ratio, *i.e.*, a ratio for which we have the gears, when the principal convergents fail. If this method does not give a suitable ratio, it will at least give the best approximation to the true ratio, from which it is easy to determine what special gear, or gears, will be required.

The change gears of the Brown & Sharpe rack cutting indexing attachment were selected as the basis of the examples presented in this article. Those who are familiar with this equipment will know that an index table (reproduced in Table VI) is provided that gives the necessary change gears for cutting all standard pitches for which the attachment is adapted, and it is needless to say that no mechanic would think of figuring out the change gears which are given in this table. The use of continued fractions is also valuable for cases where it is desired to determine the number of teeth in a pair of gears to give a certain ratio, where the numbers of teeth in the gear and pinion must be within certain specified limits. In general, continued fractions are employed to obtain approximate fractions, the values of which are very close to the value of the fraction from which they are derived.

* * *

Prof. James F. Kemp, of Columbia University, emphasized in his address to the graduating class of the Michigan College of Mines the fact that the mining engineer is a man whose measure of responsibility is not limited to engineering work alone, but upon whom, in a remote community, the welfare of hundreds or thousands of families often depends. As an example was mentioned Hjalmar Lundbohm at Kiruna, Sweden, who, far beyond the Arctic Circle, in a land where under ordinary conditions only the Laplanders, with their herds of reindeer, could eke out a scanty subsistence, has built up a community of from 8000 to 10,000 men, women and children. Here schools of the very best character have been established, comfortable homes have been built, and careful attention has been given to all matters connected with the welfare of the inhabitants, much of which is due to the ability and the generous spirit of Mr. Lundbohm; hence, there are many other sides to the mining engineering profession than ore and rocks, concentration and smelting. In more than any other branch of engineering the conditions under which the workers and their families live depend upon those in charge of the operations. It is of vastly more importance to a mining community than to an ordinary town of varied industries whether the men in power are considerate, just and sympathetic, or whether they are unscrupulous and selfish.

* * *

The specific heat of steatite, which is the essential ingredient of soapstone, is 0.21.

TABLE VI. INDEX TABLE FOR USE WITH RACK CUTTING INDEXING ATTACHMENT ON BROWN & SHARPE MILLING MACHINES

Diametral Pitch						Circular Pitch					
Pitch	Gear on Index Disk	1st Gear on Stud	No. of Turns of Index	Work Moves	Correct Pitch	Pitch	Teeth Per Inch	Diametral Pitch	Gear on Index Disk	1st Gear on Stud	No. of Turns of Index
3	88	42	2	1.047619	1.047194	1	1	3.1416	112	28	1
3½	88	49	2	0.897958	0.897598	15/16	1 1/15	3.3510	105	28	1
4	88	28	1	0.785714	0.785398	7/8	1 1/7	3.5904	98	28	1
4½	88	63	2	0.698413	0.698132	13/16	1 3/13	3.8666	91	28	1
5	88	35	1	0.628571	0.628318	4/5	1 1/4	3.9270	112	35	1
5½	112	49	1	0.571428	0.571198	3/4	1 1/3	4.1888	84	28	1
6	88	42	1	0.523809	0.523597	11/16	1 5/11	4.5696	77	28	1
7	88	49	1	0.448979	0.448799	5/8	1 1/2	4.7124	112	42	1
8	88	56	1	0.392857	0.392699	5/8	1 2/3	5.0265	70	28	1
9	88	63	1	0.349206	0.349066	2/3	1 3/4	5.2360	84	35	1
10	88	70	1	0.314285	0.314159	7/9	1 3/4	5.4978	112	49	1
11	88	77	1	0.285714	0.285599	9/16	1 7/9	5.5851	63	28	1
12	88	84	1	0.261904	0.261799	1/2	2	6.2832	56	28	1
13	88	91	1	0.241758	0.241661	7/9	2 1/4	7.0686	112	63	1
14	88	98	1	0.224489	0.224396	7/16	2 2/7	7.1808	98	56	1
15	88	105	1	0.209523	0.209439	4/7	2 1/7	7.3304	84	49	1
16	88	112	1	0.196428	0.196349	2/5	2 1/2	7.8540	56	35	1
18	44	63	1	0.174603	0.174533	5/8	2 2/3	8.3776	84	56	1
20	44	70	1	0.157142	0.157080	3/11	2 3/4	8.6394	112	77	1
22	44	77	1	0.142857	0.142799	1/3	3	9.4248	56	42	1
24	44	84	1	0.130952	0.130899	5/16	3 1/5	10.0531	70	56	1
26	44	91	1	0.120879	0.120831	3/10	3 1/3	10.4720	84	70	1
28	44	98	1	0.112245	0.112198	2/7	3 1/2	10.9956	56	49	1
30	44	105	1	0.104762	0.104719	1/4	4	12.5664	56	56	1
32	44	112	1	0.098214	0.098179	2/9	4 1/2	14.1372	56	63	1
..	..	..	.	.....	.....	1/5	5	15.7080	56	70	1
..	..	..	.	.....	.....	3/16	5 1/3	16.7552	42	56	1
..	..	..	.	.....	.....	9/11	5 1/2	17.2788	56	77	1
..	..	..	.	.....	.....	1/6	6	18.8496	56	84	1
..	..	..	.	.....	.....	1/15	6 1/2	20.4204	56	91	1
..	..	..	.	.....	.....	1/7	7	21.9911	56	98	1
..	..	..	.	.....	.....	2/15	7 1/2	23.5620	56	105	1
..	..	..	.	.....	.....	1/8	8	25.1327	56	112	1
..	..	..	.	.....	.....	1/9	9	28.2743	28	63	1
..	..	..	.	.....	.....	1/10	10	31.4159	28	70	1
..	..	..	.	.....	.....	1/12	12	37.6992	28	84	1
..	..	..	.	.....	.....	1/14	14	43.9823	28	98	1
..	..	..	.	.....	.....	1/16	16	50.2656	28	112	1

Machinery

Note: It is not necessary to change gear on screw or second gear on stud when changing for the different pitches.

A STUDY OF BELT DRIVES

BY MILES SAMPSON*

In a large manufacturing establishment in which the writer was employed, there was constant trouble with large belts which were found to wear out rapidly and to require constant attention in order to have them operate at a reasonable efficiency. Many of these drives had been designed too small for economical operation, while others had gradually become overloaded through the speeding up of machinery, the introduction of heavier work or the addition of new machinery in the plant. To overcome the difficulty and to determine standards for future reference it was decided to make an individual study of each belt over 15 inches in width, and to make a careful record of the results of these investigations. The data obtained were tabulated on the form which is presented herewith. The results shown in columns 1 to 11 were obtained by direct observation and measurement. The maximum load given in column 12 was obtained by either calculation or test. Knowing the pulley diameter and the shaft speed, the speeds tabulated in column 13 were obtained by direct calculation. The results in column 14 are calculated as follows:

$$\text{Feet per minute, per inch of belt, per horsepower} = \frac{S \times W}{\text{H.P.}}.$$

FORM USED TO TABULATE BELT DATA

Drive No.	Location				Description							Load	Speed		Ratios of Loading						Remarks
	Mill No.	Floors Driven	Motor		Double or Triple Belt	Width in Inches	Thickness in Inches	Net Length	Center to Center of Shafts	Tight Side, Top or Bottom	Angle with Horizontal, Degrees	Maximum H.P.	Actual in Feet per Minute	Per H.P. per Inch of Belt in Feet per Minute	One Inch of Belt to carry One H. P. at Speed assumed as Standard for Each Case (Feet per Minute)						
			No.	H.P.											400	450	500	550	600	650	
1	1	1 and 2	....	....	D	14½	11/32	....	....	B	Hor.	90	2100	340	....	....	....	....	1.76	....	
2	5	All	....	....	D	23½	....	....	....	Binders		360	3300	225	....	....	....	2.22	....	....	
3	6	5	....	....	D	19½	....	....	....	B	75	85	4900	1125	....	....	....	....	....	0.58	
4	8	2 and 3	36	150	D	17¼	....	....	....	B	35	174	3825	380	....	....	....	1.58	....	....	
5	10	1 and 3	....	....	T	24⅛	7/16	....	....	Binders		285	3650	285	1.40	....	....	....	....	....	Water wheel
Column No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Machinery

where S = actual speed of belt per minute;
W = width of belt in inches;
H.P. = horsepower transmitted by belt.

The results obtained by this calculation show the speed at which a belt 1 inch in width and transmitting 1 horsepower, would be loaded equally with the belt under consideration. Then by assuming a standard speed for a belt in the particular class of drive under consideration, the results presented in columns 15 to 20 are obtained, these values being given the arbitrary name "ratio of loading." The values of this ratio were obtained as follows:

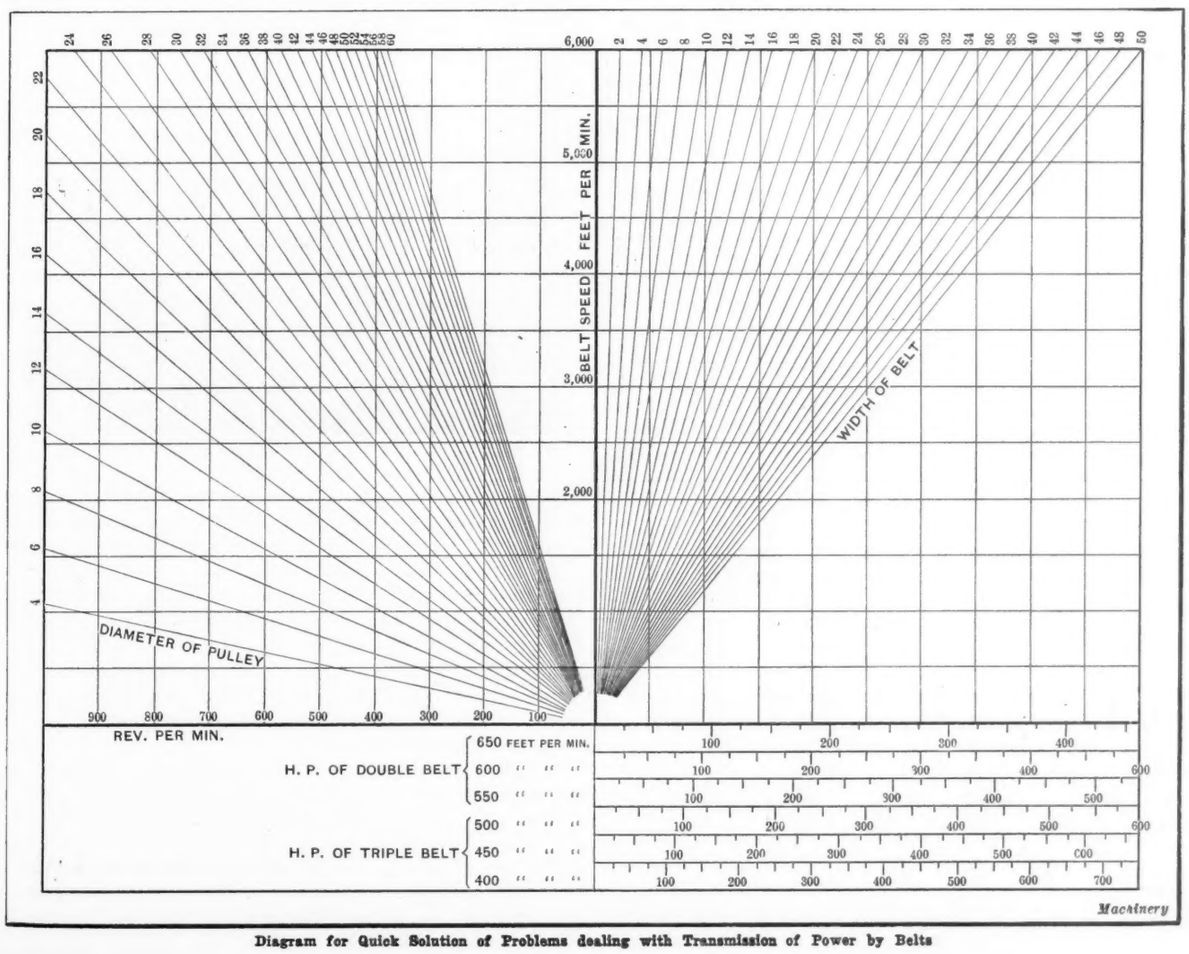


Diagram for Quick Solution of Problems dealing with Transmission of Power by Belts

* Address: 430 Manchester St., Manchester, N. H.

$$\text{Ratio of loading} = \frac{\text{Standard speed to transmit 1 H.P.}}{\text{Actual speed to transmit 1 H.P.}}.$$

With the data obtained from these investigations we proceeded to establish standards suited to the particular requirements of our own plant. These standards are given by the following: (1) For double belts 5/16 to 3/8 inch in thickness, a belt 1 inch in width should transmit 1 horsepower when running at a speed of 600 feet per minute. (2) For triple belts 7/16 to 9/16 inch in thickness a belt 1 inch in width should transmit 1 horsepower when running at 450 feet per minute. (3) A speed of 650 feet per minute for double belts and 500 feet per minute for triple belts should be allowed where conditions are bad, *i.e.*, for drives on short centers, drives in hot or dusty rooms, or drives where the belt runs over small pulleys. (4) A speed of 550 feet per minute for double belts and 400 feet per minute for triple belts should be allowed where the conditions are exceptionally good. (5) The allowances given under heads (3) and (4) should be increased or decreased, as the case may be, where the conditions are exceptionally good or particularly bad.

Having established these standards, a simple and accurate method of figuring problems in the transmission of power by belts became imperative; and after giving the subject some thought, the chart which accompanies this article was worked out and has been found exceptionally useful. In order to explain its use, assume that the number of revolutions per minute of a pulley is known and also the size of the pulley, it being required to determine the belt speed in feet per minute. The vertical line through the given number of revolutions per minute is followed to the diagonal line corresponding to the diameter of the pulley in inches; then by following the horizontal line over to the vertical scale, the belt speed in feet per minute is obtained. Having proceeded to this point and knowing the horsepower which is to be transmitted by a given belt, it will be required to determine the necessary width for the belt. The vertical line on the right-hand side of the diagram, running through the power at any required scale, is found and followed up to the horizontal line through the belt speed—which was previously determined from the diagram—and the intersection of these two lines locates the diagonal which gives the required width for the belt.

By way of conclusion it may be mentioned that in making a study of the different belts in our factory, some belts were discovered which were carrying as much as 100 per cent overload, and many belts were found to be overloaded 50 per cent. Triple belts 30 inches in width, which cost as much as $1200, were found to have been worn out and replaced after being in service for only four or five years. The results of our investigation will doubtless help to prevent such unnecessary expenses being incurred in the future.

* * *

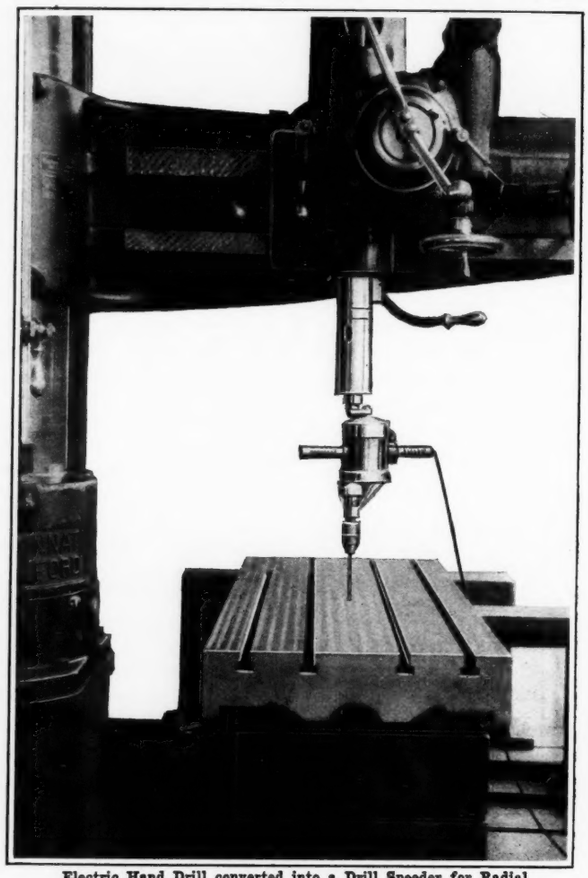
MINNEAPOLIS INDUSTRIAL EDUCATION SURVEY

For the purpose of determining just what kinds of industrial education will best meet the needs of her present and future workers, the city of Minneapolis has begun an exhaustive analysis of both her trade and school conditions, which it is expected will take about seven months to complete. In the analysis which is being made, industries are reduced to occupations and occupations to operations. The investigation seeks to find (1) to what extent the worker can "get on" in his job; (2) to what extent the city's industries may give special training which they do not now provide; (3) to what extent the schools can be a factor. It is estimated that the cost of the survey which is under the direction of a committee from the National Society for the Promotion of Industrial Education will be not less than $15,000. The findings and recommendations will furnish the basis for a large part of the discussion at the annual meeting of the National Society, which will hold its next convention in Minneapolis in January, 1916. Out of the findings of this survey and the recommendations which will come as a result of the work, Minneapolis expects to develop a program of vocational education which will put it in the fore front of American cities in the development of a comprehensive program of industrial education.

ELECTRIC SPEED DRILL FOR RADIAL DRILLING MACHINES

It is a matter of common experience to find machine parts of such size that they must be drilled under a radial drilling machine, but which have some holes that are too small to be efficiently drilled with the speeds available. The Lucas Machine Tool Co., Cleveland, Ohio, has overcome the difficulty very simply and effectively with an electric hand drill which has been converted into a drill speeder attachment. The part to be drilled under the radial drilling machine is handled in the usual way until the small holes are reached and then the main spindle is stopped and an electric drill inserted as shown in the accompanying illustration. A taper tang fitting the spindle socket has been attached to the electric drill, taking the place of the handle. The tang is provided with an off-set foot so as to bring it directly in line with the electric drill spindle.

This attachment enables the operator to drill small holes rapidly, and saves the wear and tear incident to driving a



Electric Hand Drill converted into a Drill Speeder for Radial Drilling Machine

large radial at top speed. The regular hand feed is used for feeding the drill to the work. Electric hand drills can be used thus in many places to save time and expense in drilling large castings which must be done under radial drilling machines not provided with the spindle speeds that enable them to drive small drills at the proper drilling speeds.

* * *

The fiftieth anniversary of the Worcester Polytechnic Institute will be celebrated June 6 to June 10. The main exercises will take place June 8 and 9. It is expected that on the latter day President Wilson, who was the commencement orator twenty-five years ago, will be present, provided the pressure of public business permits him to leave Washington at that time. General George W. Goethals has already accepted an invitation to be present. In connection with the celebration, there will be a special meeting of the American Society of Mechanical Engineers at 2.00 P. M., June 9, to be held at the works of the Norton Co., at which meeting papers will be read and discussed.

PERCUSSIVE ELECTRIC WELDING*†

PROCESS AND MACHINES FOR UNITING SIMILAR OR DISSIMILAR METALS BY PERCUSSIVE ENGAGEMENT

BY DOUGLAS T. HAMILTON‡

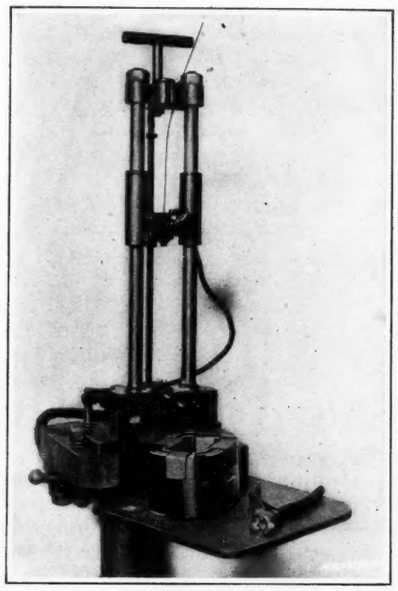


Fig. 1. Portable Percussive Electric Welding Machine

PERCUSSIVE electric welding which is one of the latest developments in the electric welding art, was originated by L. W. Chubb of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. During the year 1905, while Mr. Chubb was experimenting with electrolytic condensers and rectifiers in the research department of this company, he noticed that the wires could be connected to the aluminum plate by the condenser spark when the cells were discharged. It was also noticed that copper wires could be attached to aluminum or that two pieces of aluminum could be joined by the condenser spark. The joint thus made, however, was not strong, but after a careful consideration of the results of these early tests, it was decided to try out this method of welding with a greater condenser discharge.

This method of electric welding was first applied to the welding of aluminum, because this metal had given such trouble in soldering, especially when joining small wires. With the substitution of aluminum wire for copper wire, which has taken place in the last few years, the need for a good means of joining aluminum has become urgent, and the percussive electric method was developed primarily for this purpose after a thorough investigation of the methods available. In addition to the welding of wire, several other special applications have been successfully made, so that a general review of some of the more important points should be of interest. Percussive electric welding differs from the resistance method chiefly in the nature of the current used. For resistance electric welding, alternating current is used, whereas for percussive welding direct current is employed. It is possible to weld any two metals, whether alike or different, of high or low melting points or of an unequal thermal conductivity. With aluminum, the oxide which covers the surface of the pieces being welded prevents the metals from flowing together after the ends have been melted in the usual way. Large wires and rods of aluminum can be welded by melting the metal under the oxide film and then suddenly pushing the ends of the pieces together, breaking the oxide film and allowing the clean metal to flow together, but on small wire this practice is not feasible.

Development of Percussive Electric Welding Apparatus

Following up the experiments made in 1905, Mr. Chubb designed a condenser giving a discharge on a larger scale, and employing the same principle of simultaneous condenser discharge and percussive engagement that had been used in the original experiments. During the test and development of the welding apparatus, however, it was found that the best results depended upon several variables, such as the condenser capacity, the velocity and force of impact, the voltage and the resistance and induction in the circuit. The first apparatus consisted of two hinged arms with wire grips in their ends. Wires placed in the grips were connected to the terminals of a charged electrolytic condenser. Upon being released, these arms were drawn together and at the instant of contact of the wires, the explosive condenser discharged and the force of impact welded the ends together. This apparatus was not very satisfactory, as it did not allow of a separate study of the effect of the variations in velocity, momentum, kinetic energy, etc. A second apparatus similar in construction to a pile driver on a small scale was then built. This was provided with one stationary and one movable wire grip or chuck. In this apparatus the "forge effect" and velocity could be varied independently by a separate adjustment of the length of drop and mass of the moving parts. Other welding tools have been designed in which springs have been used to shoot the wire holders together horizontally, but this type of device has not been as satisfactory as the "drop-hammer" type.

Construction of Percussive Electric Welding Apparatus

A percussive electric welding device of the portable type is shown in Figs. 1, 2 and 3. Fig. 1 shows this device set up for welding a copper lead wire to a coil of aluminum wire, and Fig. 2 shows plan and sectional elevations of the device.

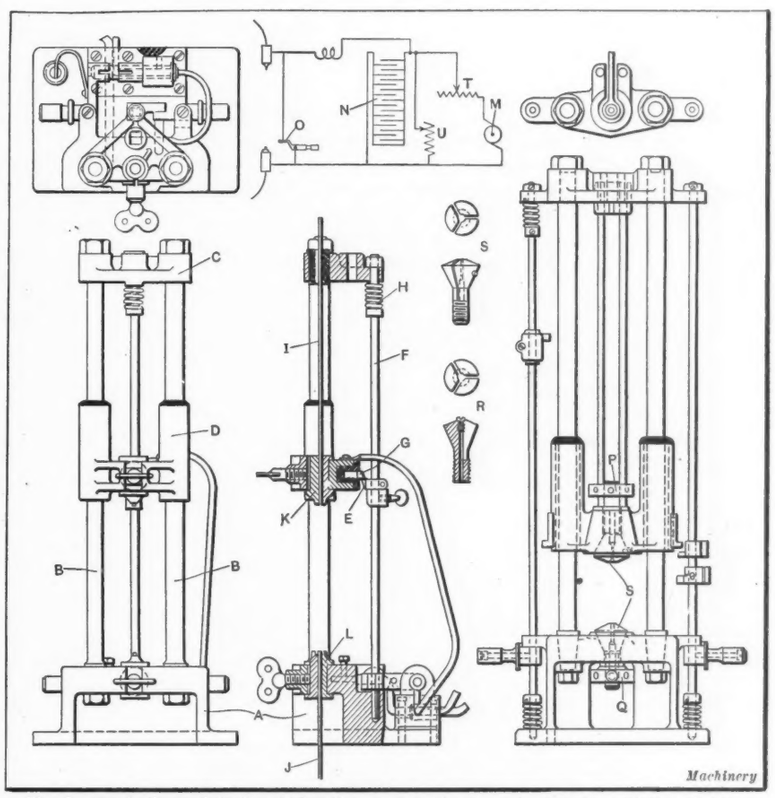


Fig. 2. Front Plan and Sectional Elevation of Portable Percussive Electric Welding Machine and its Connections—Two Types of Machines Illustrated

* For additional information on electric welding see "Special Electric Butt-welding Machines," published in the May number of MACHINERY, and other articles there referred to.

† Illustrations Figs. 1, 3, 5, 6, 7, 8, 9, 11, 12 and 13 used through courtesy of "The Electric Journal."

‡ Associate Editor of MACHINERY.

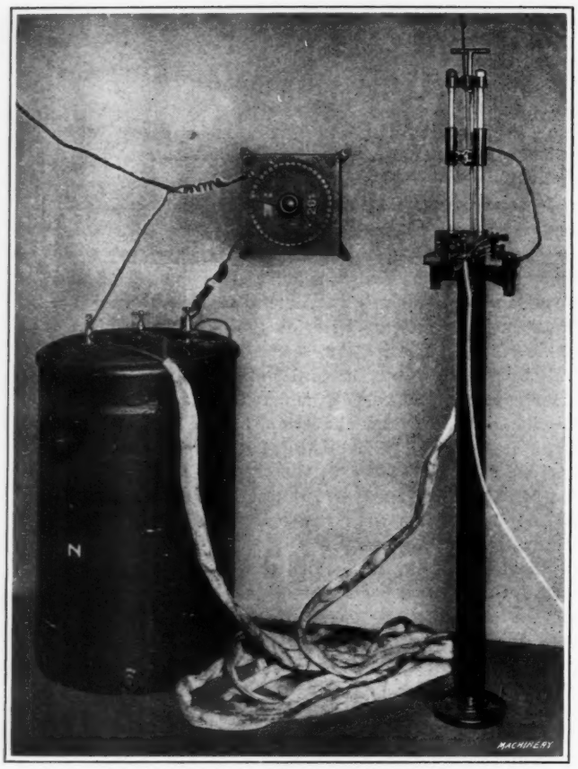


Fig. 3. Complete Percussive Electric Welding Outfit, comprising Electric Welding Machine, Rheostat, Electrolytic Condenser and Connections

Referring to Fig. 2, it will be seen that this machine has a base *A* carrying two parallel uprights *B*, which are held together at the top by stationary head *C*. Sliding on these guides *B* is a carriage or head *D* which carries a clamping chuck for holding one of the pieces of wire to be welded.

In order to support carriage *D* in a raised position, adjustable trip *E* held on the rod *F* is provided. Trip *E* contacts with trip *G*, held in the sliding head *D*, and is insulated from it. Rod *F* is so located in its bearings that it can be rotated to bring trips *E* and *G* into alignment with each other. Both trips *E* and *G* are beveled, enabling carriage *D* to be raised, but not lowered until trip *E* is released by a slight rotative movement of the rod *F*, which is again returned to its operative position by means of spring *H*. The wires *I* and *J* to be welded are held in chucks *K* and *L*. Clamping chuck *L* has the general form of a spool or flanged cylinder, and is split longitudinally into two parts which are grooved to receive one of the wires to be welded. The chuck is mounted in a slot in the base of the machine and is held in position and also caused to grip the wire by a thumb-nut. The clamping chuck *K* is similar to *L*, and is held in the same manner. The other wire *I* to be welded is conducted down through the top cap of the machine as illustrated, passing through an insulating bushing.

The electrical energy (see Figs. 2 and 3) is supplied from a generator *M*, or any source of direct current, which charges the electrolytic condenser *N*. There is a high resistance *T* in the circuit, and the condenser charge can be varied by resistors *T* and *U*. In operation, the pieces of wire *I* and *J* to be welded are secured in the chucks *K* and *L* so as to project out from the chuck for a short distance. The carriage *D* is then raised to the desired height, which is determined by the setting of the trip *E*. The position of trip *E* is governed by the diameter and composition of the wire to be welded. After the wire has been clamped in position and trip *E* properly set, switch *O* is opened to permit generator *M* to charge condenser *N*. Trip *E* is then released from trip *G*, allowing the carriage to drop and carry the end of the wire *I* into percussive engagement with the end of wire *J*. At the instant of contact, the condenser *N* is discharged, and the energy thus concentrated at the point of contact is sufficiently great to produce a perfect weld between the wires. The weld is then complete, and after being removed from the machine the wire will be found to have the same strength at the joint as anywhere else.

A percussive electric welding machine embodying the general principles just described, but of slightly different construction, is shown to the right of Fig. 2. In this machine the tripping mechanism is guided by two rods instead of one, and it is also provided with a different type of work-holding chuck, which is shaped similarly to that used on a screw machine and is also split to allow for expansion and contraction. The chuck body is tapered to fit into a correspondingly shaped hole in the base and sliding head of the machine, and is tightened on the work by means of nuts *P* and *Q*. The jaws of these chucks may be threaded as shown at *R* to adapt them to receive small screws if desired. By supporting a small screw in this manner in the chuck and holding a section of platinum wire in the upper chuck, the screw may be easily provided with a platinum tip. Each of the chucks has a pin projection which engages a notch in the holder for the purpose of preventing the chuck from rotating when the nut is being tightened.

Description of Percussive Electric Welding Process

The action that takes place when the wires are percussively engaged covers such a short period of time that it is practically impossible to see it with the naked eye. The only possible way of analyzing the action is to consider it from a theoretical standpoint. From careful observation of a large number of welds and the study of oscillogram records, the theoretical action that takes place between the engaging terminals of the rods to be welded has been graphically set forth as shown in Fig. 4. At *A* the wires to be joined are shown close together as they appear when approaching each other. It will be noticed here that the ends of the wire have been provided with chisel-shaped edges, arranged at right angles to each other. This is done so that the first engagement between the two wires is at a small point. These chisel-shaped edges require no particular care in making, and in fact the thin edge usually produced when wires or rods are cut off with an ordinary pair of pliers or shearing device is satisfactory.

At the instant of contact *B*, the voltage of the circuit falls away as shown by the curve *a*. The current and power, on the other hand, increase rapidly as indicated by curves *b* and *c*. In this particular case, the voltage drops from approximately 207 volts to 160 volts in 0.0001 second and reaches zero at the end of 0.00035 second. The power expended in the circuit rises from zero to 23,000 watts in 0.0001 second,

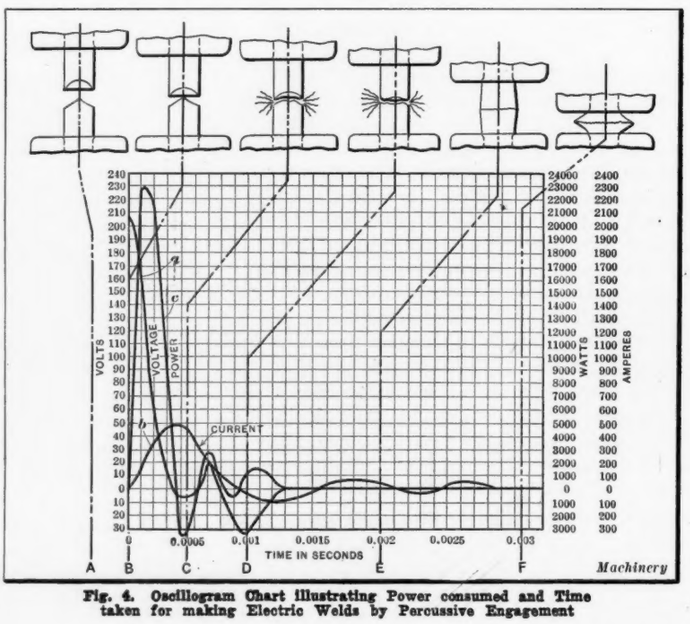


Fig. 4. Oscillogram Chart illustrating Power consumed and Time taken for making Electric Welds by Percussive Engagement

Fig. 5. Microphotograph of Copper and Aluminum Wire electrically welded showing Intermingling of Metals—magnified 850 Times

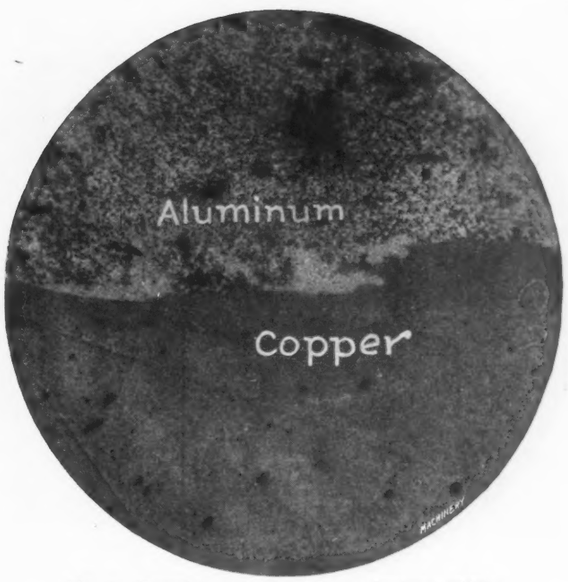


Fig. 6. Microphotograph of a Copper-aluminum Weld—magnified 850 Times

and then almost as suddenly decreases crossing the zero line with the voltage. The weld in this case is completed electrically, that is, so far as a perfect junction of the two metals is concerned, in 0.0012 second, although the upsetting action still continues to forge the metals together until the upper chuck is brought to rest. Although 23 kilowatts is being dissipated between the ends of the wire at a certain instant, the total energy used at the weld is only 0.00000123 kilowatt hour, or enough to light an ordinary 50-watt 16-candlepower lamp for 0.09 second. The cost of this amount of energy at ten cents per kilowatt hour would be twelve-millionths of a cent. Referring to Fig. 4, it will be noticed that the watt curve *c* is oscillatory and that the negative value would indicate a return of stored energy. Such an action would be impossible from a metallic arc, but can be explained by the fact that the voltage was measured above and below instead of between the wire chucks, so that the storage and return of energy is from the magnetic flux produced in the steel chuck set up by the current of 500 amperes flowing through them.

The time between the first contact and the finished weld is of such short duration that the exact action cannot be recorded, but is supposed to be about as shown in Fig. 4. At *A* the wires are approaching each other at a velocity of about 65 to 200 centimeters per second (25.59 to 78.74 inches). At *B* the first contact is made, at which time the current begins to build up and heat the small section of metal carrying the current. At *C* the ends of the wire have separated, not by any appreciable retarding or reversing of the motion of the upper wire but by the melting and vaporizing of the metal which first came into contact. At *D* the wire chucks are closer together, but the arc is still burning between the wires. At *E* the second contact has been made, the arc extinguished and the upsetting of the metal has begun. At *F* the complete weld is shown after the upper chuck has come to rest and the upsetting is completed.

The generation of heat is so localized, so sudden, and so intense that there is no time for unequal heat conduction through the shanks of the wire, and the ends will be melted and even vaporized whether the melting point of the metal is high or low. For this reason various metals and alloys can be welded together independently of their electrical resistance, melting point or heat conductance. All the combinations of metals or alloys that have been tried will weld together, but the joints will not be permanent with such combinations as aluminum and tin or lead and iron.

Interesting Phenomena in Percussive Electric Welding of Metals

Although the action of percussive welding is complex, as indicated by the chart, Fig. 4, it is not necessary to construct the welding apparatus or to adjust its parts with more than an ordinary degree of accuracy. Furthermore, it is not neces-

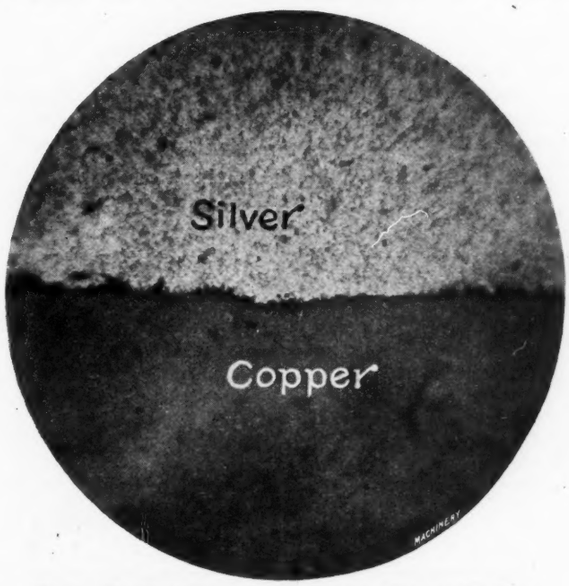


Fig. 7. Microphotograph of a Copper-silver Joint showing Sharp Line of Demarkation at Point of Weld—magnified 1000 Times

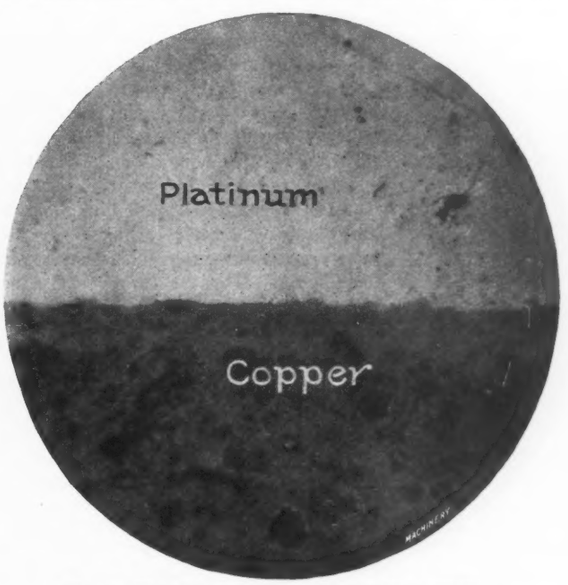


Fig. 8. Microphotograph of a Copper-platinum Weld—magnified 1000 Times

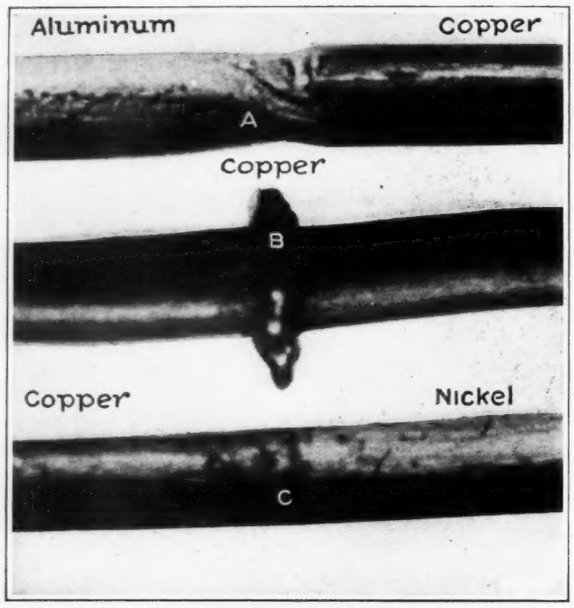


Fig. 9. Nickel, Copper and Aluminum Wires united by Percussive Electric Welding, showing Condition of Metal at Welded Joint

sary to be very careful about determining the capacity of the condenser, the voltage of the charging circuit, or the inductance of the welding circuit. As an example, perfect welds have been made on the first trial between such metals as tin and platinum, platinum and nickel, and copper and aluminum, without special precautions, calculations or adjustments. While the machine is relatively light, a sufficient compression is obtained to forge the terminals of the metals to be welded, and by the use of a condenser of suitable design and capacity a sufficiently intense heat is supplied for a fraction of a second to melt the engaging surfaces and weld such metals as platinum and tin without injury to either metal.

It is believed that such a tremendous amount of energy relative to the size of the conductors not only fuses the engaging surfaces but vaporizes them, producing a small explosion and actually separating the solid portion of the wires for an instant as shown at *C* in Fig. 4. At this stage of the welding action the terminals of the wire being welded are surrounded by a metal vapor. That this is true is abundantly proved by deposits of metal particles found on the chucks of the welding machine after a number of welding operations have been performed. It is believed that metal vapor surrounds the terminals before they are brought into permanent engagement, and that this is one of the reasons why successful joints have been secured between such unlike metals as aluminum and copper and between two aluminum conductors, the surfaces of which become oxidized with extreme rapidity when exposed to the air under ordinary welding conditions. It is thought that the small explosion previously referred to actually blows out a certain portion of the terminals in the form of vapor and consumes such a short time that the mechanical energy produced by the dropping of the chucks is still effective in welding the "wetted" terminals. The terminals are not permitted to cool after the explosion and previous to their percussive engagement because the current in the welding circuit as indicated by the curve *b*, does not die out immediately, but continues to oscillate for several thousandths of a second.

Nature of the Work Produced by Percussion Welding

It has been found that on account of the intense heat that can be concentrated at the desired point for a short period of time the electric percussive method is particularly effective in making a satisfactory joint. The effect of the concentration of energy referred to on an aluminum wire is to vaporize a small quantity of the aluminum on the engaging surfaces, thereby blowing out laterally in all directions the vaporized material, and carrying off, or at least breaking up, the oxide film which has hitherto prevented the welding of aluminum successfully. In the welding of copper to aluminum by the percussive method it would be expected that the joint would be unsatisfactory, owing to the fact that certain combinations of these metals form a brittle alloy. This, however, is not the case, as welds between these two metals are so ductile that they may be worked in a die, forged or rolled into thin foil. Any alloy that is formed at the junction of the aluminum and copper wires must range from 100 per cent copper on one side to 100 per cent aluminum on the other, but possibly the brittle combinations are so thin that the joint as a whole is flexible and ductile. The possibility of making satisfactory joints between aluminum and copper is of great commercial importance, as copper feed wires which solder easily can be welded to aluminum coils. It was thought at first that a diffusion of the two metals in service would result in a brittle joint, but tests show that after four years the joint is apparently as strong and ductile as when first made. Similar ductility has been noted in almost every combination of metals when first welded, but diffusion, disintegration and loss of ductility eventually result in such welds as silver to tin or aluminum to tin; the welds are effected by what is known in the trade as "tin disease" or "tin-pest"—a disintegration of the molecules.

Metals which are either hardened or softened with heat and sudden cooling can be welded together without appreciable change in the physical properties of the material. Tempered spring steel wire welded and reduced to uniform diameter and tested has shown equal or greater strength at or near the weld without any noticeable change in temper. Metals such as hard drawn copper, silver, aluminum, etc., can be welded without causing any local annealing, and these metals, as well as soft steel, can be welded together without detrimental local hardening. In welding unlike metals by the ordinary method of electric welding a brittle alloy is sometimes formed between the joints of the metal. In percussion welding this is not the case, as the energy and heat are so concentrated, and continue for such a short interval, that there is no appreciable flowing of one metal into the other, the line of demarkation being very sharp, even when the welded pieces are rolled out into a thin sheet or foil. If a film of alloy is produced at the joint, the film is so thin that it is flexible. This is true of various combinations of metals, as will be described later.

Explanation of Supposed Lack of Change in Molecular Structure in Parts Electro-Percussively Welded

Several explanations are given for the mechanical properties of various metals before and after welding; some of these are: First, such a sudden heating and cooling may not allow change in molecular structure; second, with hard steel, the heated metal at the weld is so suddenly cooled by conduction of heat into the adjacent cold metal that it is again hardened; third, with hard copper, silver, aluminum, etc., the heating and sudden cooling would ordinarily soften the metal, but the cold upsetting of the blow in welding possibly hardens it again; fourth, the metal is subjected to the sudden heating and cooling so that it may be hardened or annealed (depending upon the characteristics of the material welded), but the amount of material affected may be too small to be detected.

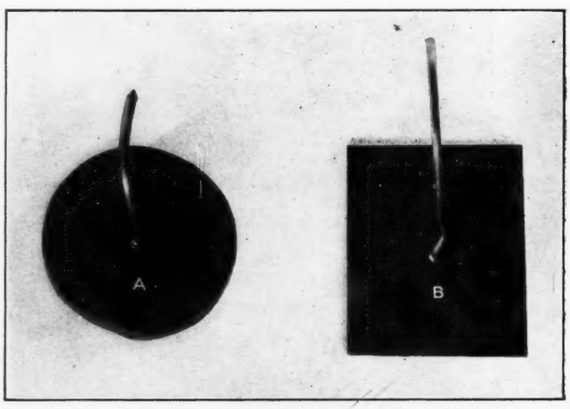


Fig. 10. Examples of Butt-welding Operations performed by Percussive Electric Welding Apparatus

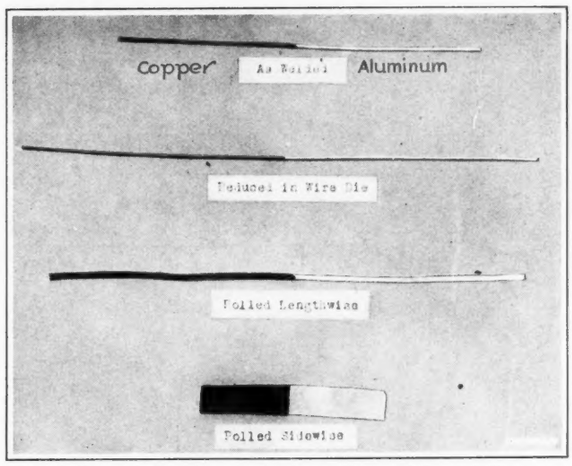


Fig. 11. Examples of Aluminum-Copper Welds on Wire manipulated to show Ductility and Malleability of Weld

As an example, in welding No. 18 (0.043 inch diameter) hard-drawn aluminum wire, 0.00123 watt-hour or 1.06 small calories are dissipated at the weld. Assuming that none of the energy is lost in noise, radiation or metallic vapor and that one-half of the total is propagated in a heat wave in each direction along the wire, it can be shown mathematically that an annealing temperature will not be reached more than 0.05 millimeter (0.002 inch) from the weld. The total amount of metal softened would be a disk 0.1 millimeter (0.0039 inch) long and 1.02 millimeter (0.0403 inch) in diameter. A soft insertion of such proportions could hardly be detected.

In welds between some metals diffusion takes place, but in any of the useful combinations the change is too slight to affect the ductility of the weld. The welds, as a rule, show only a sharp dividing line between the metals, but there is often an intermingling of the two at or near the center for a short distance. Figs. 5 and 6 show a new weld and a three-year old weld between aluminum and copper. The microphotographs, which are enlarged 850 times, were taken at the irregular point in the weld; elsewhere the line of division is sharp and rather straight. In addition to the small irregularity of the dividing line, some spots of bright material, possibly aluminum-copper alloy, are present at this point, but do not appear at other points in the weld. Both of these welds are so malleable that they are capable of being rolled into thin foil. Wire having such welds was used in actual service at a temperature over 100 degrees C. (212 degrees F.) carrying a heavy direct current, and failed to show sufficient diffusion to affect its mechanical properties. The heating current was maintained for weeks and tests were made with the current flowing in both directions. At higher temperatures (red heat) there was a rapid diffusion of the metals, and in a few minutes the metals were diffused for a distance of two or three inches. A percussive electric weld offers a very convenient specimen for the study of the diffusion of different metals at different temperatures and under various conditions. The microphotographs Figs. 7 and 8 show copper-silver and copper-platinum welds, respectively. Both of these welds show a sharp dividing line when enlarged to 1000 diameters. The weld, Fig. 8, is three years old.

It has been found that the electrical resistance of two wires welded together is not appreciably increased by the small film of high resistance alloy at the joint formed in welding. Tests on eighty-five alternate pieces of aluminum and copper wire joined with eighty-four welds, making a total length of 23.5 centimeters (9.254 inches) showed an increase of 0.56 per cent in resistance in three years. This test was made to determine whether or not diffusion at the joints would occur. The increase is small and may be due to a change in the joints, or error in observation or oxidization. This sample was recently rolled and showed no change in malleability.

Metals that can be Electro-Percussively Welded

Thus far, no difficulty has been experienced in welding together any metal or alloys of metals, nor in fact, any combination of metals or alloys. The following are a few of the combinations that have been welded. Tin to aluminum, copper and platinum; lead to tin; tin to platinum; tin to copper; nickel to platinum; steel of various alloys and carbon contents. The chief advantage of the electro-percussive method of welding at present is in the uniting of copper and aluminum, since it is almost impossible to make this weld with the other well-known methods, and when made by the resistance method the joints are as brittle as glass. Another interesting feature of the joint made in wires of different materials by percussion welding is the fact that the metal is just as ductile at the weld as it is any other place along the surface. Fig. 9 shows various combinations of metals that have been electro-percussively welded. At *A* is shown a piece of aluminum wire welded to a piece of copper and subsequently reduced by drawing the wire through a die. It will be noticed that the aluminum wire has "disintegrated" to a certain extent at the joint but is still firm. This wire has been magnified eighteen times. At *B* is shown a joint of copper to copper with a slight flash. When this flash is removed it will be possible to draw out the wire without showing any change in shape or reduction in diameter at the joint. The reason for this is assumed to be that the action of welding is of such a nature that the fused or volatilized metal is completely expelled and the cold metals come together to form the joint with a very thin film between them. At *C* is shown a piece of copper wire welded to nickel. Upon looking closely at this illustration it will be noticed that when the wire was drawn out there was practically no difference in diameter at the joint between the copper and nickel wire. This has been magnified eighteen times.

Examples of Electro-Percussive Welding

While the development of this method of electric welding was brought about primarily to secure successful joints between aluminum and copper wires, it is evident that it possesses wide application. Metals varying widely in characteristics, such as platinum and tin, may easily be welded, from which it follows that almost any metal can be joined where the joint is within the capacity of the machine. The apparatus up to this time has only been made for welding wires 0.072 inch in diameter and smaller, but there is no reason why, with a larger machine and suitable apparatus, wires much larger than this could not be welded as well as other classes of work. Sufficient experimenting has been done to show that the welding of wires to plates or blocks can be successfully accomplished. Fig. 10 shows two examples along this line. At *B* a piece of 1/32-inch copper wire has been electrically butt-welded to a piece of copper 3/16 inch thick; whereas at *A* a piece of 1/32-inch copper wire has been butt-welded to a piece of 1/32-inch sheet brass. In the ordinary method of electric welding, it would be practically impossible to join these two pieces for the simple reason that the area of one is so much greater than the other that the wire would fuse and melt away before any perfect junction could be secured. By means of percussive welding, this operation is comparatively simple and a joint is made that is as homogeneous and strong as the metal itself.

In order to determine just what effect manipulation of the stock would have on the welded section, copper and aluminum wires, as shown in Fig. 11, have been welded, drawn and rolled. The first view shows copper and aluminum wires welded together; in the second view these two pieces of wire have been reduced in diameter by drawing; in the third

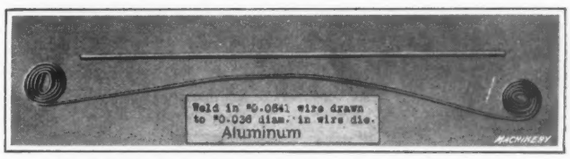


Fig. 12. Sample of Aluminum Wire welded and drawn through Die without Disintegration at Joint

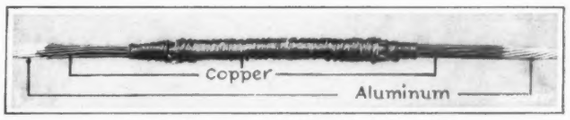


Fig. 13. Method of splicing Aluminum Cables

view the wire has been rolled out lengthwise; and in the fourth view a section of this wire is shown rolled out sideways. A study of these metals under different manipulating processes is interesting. It will be noticed in the first view that the joint is almost straight across the wire, but after drawing, the aluminum wire, which is slightly softer than the copper wire, has been reduced a little at the joint, and the copper wire has overlapped the aluminum wire in one place. This same condition is shown in the third view where the copper has rolled into the aluminum. Probably the most interesting condition is shown in the fourth view where the wire has been rolled sideways. Here it will be seen that the line of demarkation between the aluminum and the copper wire is extremely sharp and that it is practically straight across the section, showing that the two metals came together when practically in a cold state and that the film of fused metal between them must have been extremely thin.

In order to show the ductility of metals when percussively welded, two pieces of aluminum wire were joined as shown in Fig. 12. This piece of aluminum wire, which was 0.0641 inch in diameter after welding, was then drawn down to 0.036 inch in diameter through a wire die. The point at which the weld was made could not be determined even under a microscope, which showed that there was no physical change in the wire due to welding and that as far as ductility was concerned the metal was just as ductile at the weld as it was any other place along the section. Another interesting use of this art is shown in Fig. 13. This illustrates a method of splicing aluminum cables. This is done by welding a short length of copper to each strand of the aluminum cable, and then twisting or wrapping the copper wire around the joint, and soldering the ends. After the joint is soldered, an aluminum tube is placed over the joints to prevent any electrolytic action between the copper and aluminum wires.

There are also many uses of the electro-percussive method, especially in the jewelry trade, where it can be employed for joining platinum without showing any solder line; welding sterling tips to table forks without annealing; welding pins to badges; and many other similar applications. The attaching of contact points of platinum, tungsten, silver, etc., for various electrical purposes is also readily accomplished.

* * *

A SIMPLE MAGAZINE ATTACHMENT

BY E. WHITNEY

A magazine for automatic screw machines consisting of a rod, a tube and a special feed finger is described in the following. In order that automatic screw machines may sometimes handle a larger diameter of stock than usual, the spindle tube is removed and a feed finger *A* is constructed, as shown in Fig. 1. This feed finger is used backward and is located outside the spindle instead of inside. The groove *B* is provided to receive the latch key which is regularly latched in the back of the spindle tube. This style of feed finger affords a practical means of automatically handling washers of the form shown at *C*, and similar parts on which it is required to have a second operation performed. In the case of the washers *C*, the second operation for which the magazine is used consists of countersinking them as shown by the dotted lines. The magazine consists of the rod *D* which is loaded with washers and inserted in the spindle. As many washers may be carried in one loading as will fill the spindle and feed finger. The tube *E* is used as a "shover" to push the washers into the chuck, and after one washer has been finished, the next one coming into place will eject it as shown in Fig. 2. It will be necessary, of course, to keep the rod

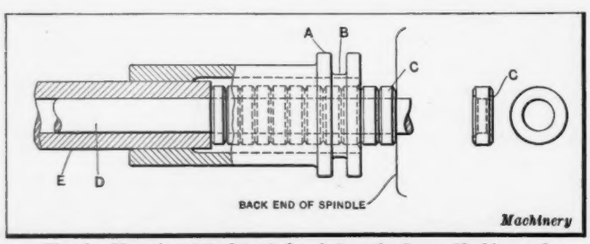


Fig. 1. Magazine Attachment for Automatic Screw Machine and Class of Work for which it is used

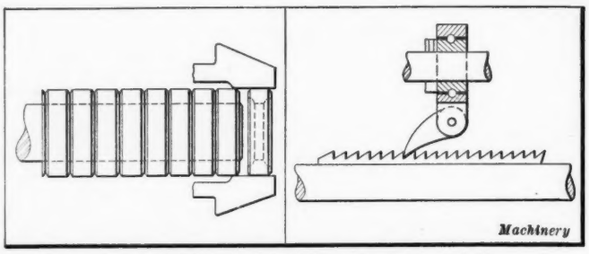


Fig. 2. How the Work is ejected from the Chuck, and Means of holding the "Shover" Tube Stationary

immovable, and this can easily be done by making use of one of the stands provided for supporting the stock.

The question may arise as to how the tube *E* is held stationary while the feed finger slides back over it the distance required for feeding out a new piece. In ordinary work, the chuck grips the end of the bar while the feed finger slides over it, but, when using the feed finger shown in Fig. 1 for short bars or for magazine purposes, a special clutch device is required. The simplest means of providing for this is to fasten a collar to the stock as shown in Fig. 2; this collar has a ball bearing, the inside of which is fastened to the stock with a set-screw, while the outside carries the pawl which engages in the rack. This rack is carried by a rod

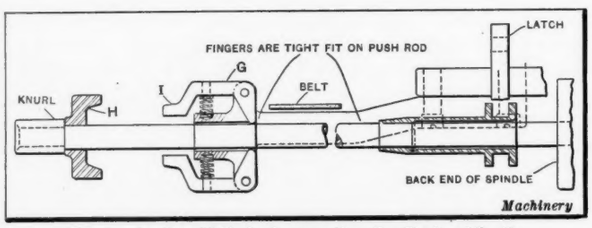


Fig. 3. Another Method of supporting the Stock while the Feed Finger is taking hold

mounted to the stock supporting stands. Another method of supporting the stock while the feed finger is taking hold is shown in Fig. 3. Clutch fingers *G* are held against the stock by the coiled springs, and these fingers are set ahead of the center so that the stock will slide freely in one direction and be prevented from sliding in the opposite direction. The method of using this device for stock was to use up all the 10-foot bars as far as possible, after which the clutch was attached for the short bars. At *H* is seen a cap which, engaging the ends of the fingers *I*, will release the clutch fingers the moment the last piece has ben cut off from the bar. This prevents unnecessary wear on the feed fingers.

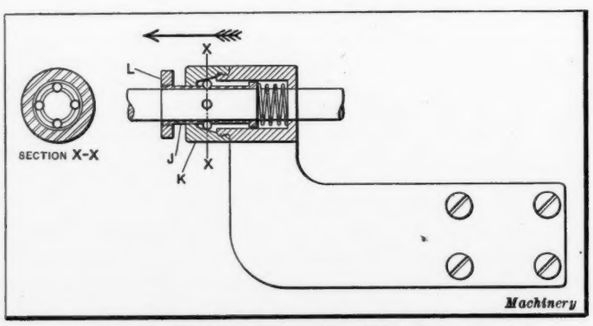


Fig. 4. Ball Clutch Device to replace Mechanisms shown in Figs. 2 and 3

Fig. 4 shows another device which is used for the same purpose. Many small shops will find it convenient in performing light operations on steel and brass stock over 1 inch in diameter on the No. 2 Brown & Sharpe machines, and up to 7/16 inch diameter on the No. 00 machine made by the same company. On the device shown in Fig. 4, four balls are used as a clutch. It will be noticed that these balls are carried in small pockets in the tube *J* so that the coiled spring will keep the balls in contact with the tapered interior of the cap *K*. The balls will prevent the shoving-rod from sliding in the direction of the arrow, but will allow the feed finger to move it in the opposite direction. By pushing the knob *L*, the clutch may be released so that the rod can be moved by hand.

MACHINING FLYWHEELS

TOOLING AND METHOD OF OPERATION AS APPLIED TO THE CONRADSON MULTIPLE-SPINDLE AUTOMATIC

THE Conradson multiple-spindle automatic, which is built by the Giddings & Lewis Mfg. Co., Fond du Lac, Wis., is well adapted for handling those classes of work which require a succession of operations to complete them. The machining of flywheels is a case in point, and it is the purpose of the present article to describe the method of procedure in handling this work. One of the No. 0 machines tooled up for machining flywheels is illustrated in Fig. 1; and Fig. 4 shows details of the type of flywheel to be machined. In handling these parts, the work is passed through the machine along the path shown diagrammatically in Fig. 5. Reference to this illustration will show that the table is indexed through two stations at a time. The chucks are loaded at station No. 1, after which the table is indexed twice to bring the work to station No. 3, where the first operation is performed; the next indexing brings the work to station No. 5 where the second operation is performed. The second operation completes the machining of one side of the flywheel and the work is then indexed back to the starting point at station No. 1, where the work is removed from the chuck and re-set in the chuck under station No. 2 ready to have the necessary operations performed on the opposite side of the wheel. After setting up the work, the table is again indexed through two stations, bringing it first to station No. 4 where the first operation on the back of the wheel is performed, and then to station No. 6 where the final operation is conducted. The flywheel is now finished and is indexed back to station No. 2, where it is removed from the chuck. Fig. 2 shows a view of station No. 1 at *A*, station No. 2 at *B*, and station No. 6 at *C;* station No. 4 is shown at *D* in Fig. 3, and station No. 5 at *E;* Fig. 6 shows station No. 3 at *F* and station No. 4 at *G*.

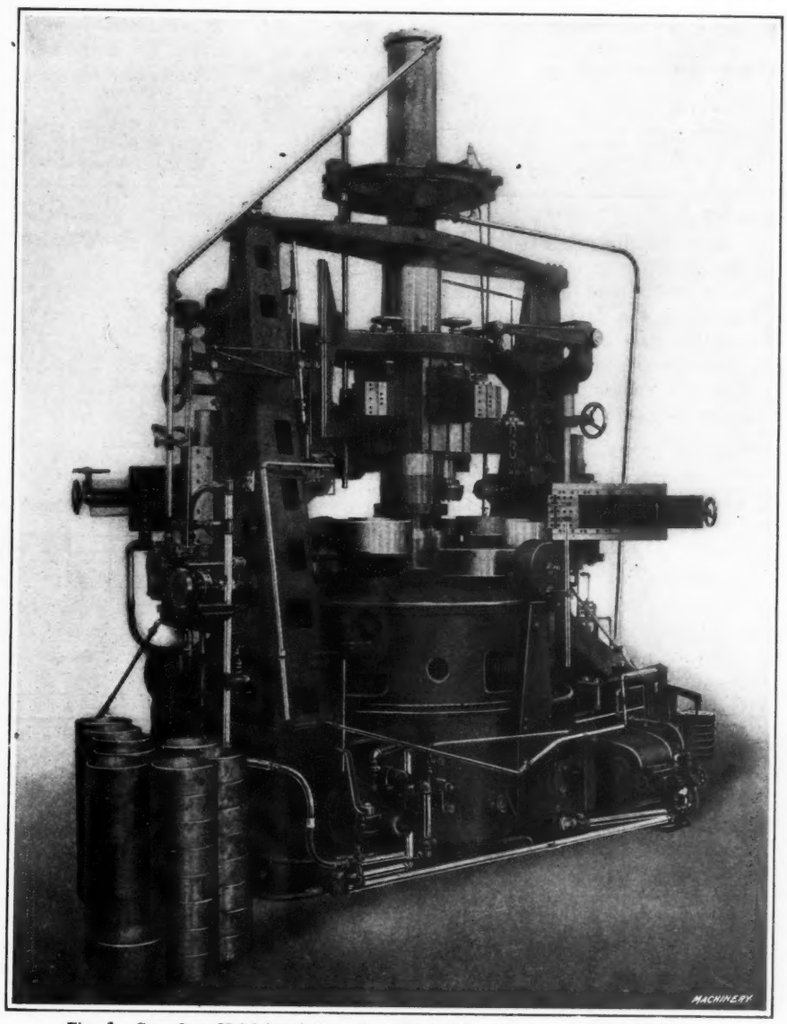


Fig. 1. Conradson Multiple-spindle Automatic tooled up for machining Flywheels

Having briefly described the method by which the machining of flywheels is conducted on the Conradson automatic, we are now in a position to give a more detailed description of the individual operations involved. Station No. 3 is shown at *F* in Fig. 6, and it will be remembered that this is the station where the first operation on the flywheels is performed. This operation includes turning the outside of the blank, facing the two edges, boring the taper on the inside of the rim, boring the center hole, and facing the hub. The tools employed for this purpose are shown in Fig. 7; and in this illustration, the dotted lines indicate the rough-

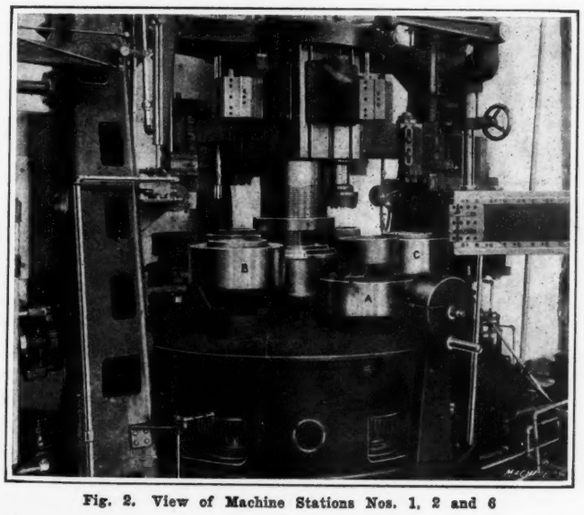


Fig. 2. View of Machine Stations Nos. 1, 2 and 6

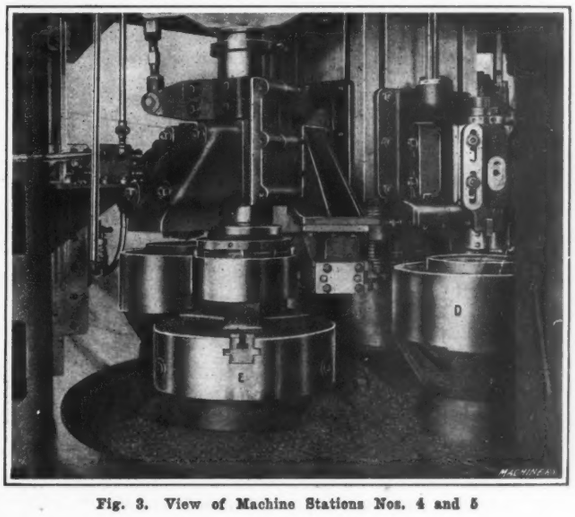


Fig. 3. View of Machine Stations Nos. 4 and 5

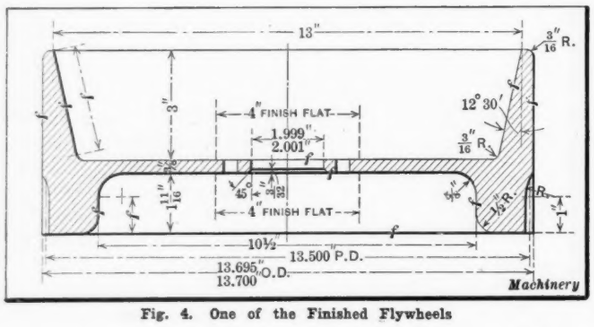


Fig. 4. One of the Finished Flywheels

ing cuts which are taken. After the first operation has been completed, the work is indexed to station No. 5, which is shown at *E* in Fig. 3. Here the second operation is performed which consists of finishing the surfaces from which a roughing cut was taken in the first operation. The tools provided at station No. 5 are shown in detail in Fig. 8, and reference to this illustration will show that the work performed consists of reaming the central hole in the hub, finishing the tapered clutch surface on the inside of the rim with a conical reamer, taking a finishing cut over the outside face of the wheel with a suitable turning tool, and finishing the top edge of the flywheel with a form tool. After these operations have been performed, the work is carried on to station No. 1, shown at *A* in Fig. 2, where it is removed from the chuck.

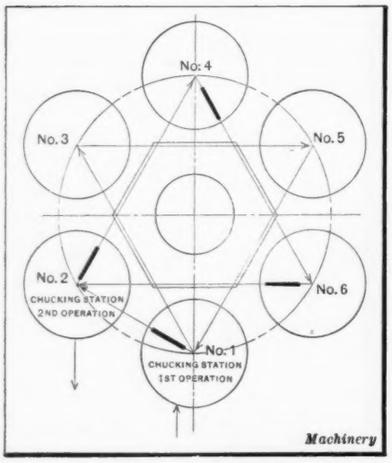


Fig. 5. Diagram showing Passage of Work through Machine

It has already been stated that for performing the necessary operations on the back side of the flywheel, the work is set up at station No. 2, shown at *B* in Fig. 2; and for this purpose, it is held in the collet chuck shown in operation in Fig. 2, and in detail in Fig. 9. The work is now indexed to station No. 4, shown at *D* in Fig. 3; the work is shown in this position at *G* in Fig. 6, and the tools provided for taking the roughing cuts are shown in detail in Fig. 10. Reference to the latter illustration will show that the work consists of taking a roughing cut over the edge and inside of the rim of the wheel. The work is then indexed to station No. 6, shown at *C* in Fig. 2, where finishing cuts are taken over those surfaces which were roughed out by the preceding operation; and the edge of the central hole in the wheel is also chamfered off to an angle of 45 degrees. The tools provided at station No. 6 are shown in detail in Fig. 11. After this has been done, the flywheel is completed and it is merely necessary to carry it on to station No. 2, where the finished work is removed from the chuck and replaced by a new blank. The total time required to finish one of these flywheels is said to be only 4½ minutes.

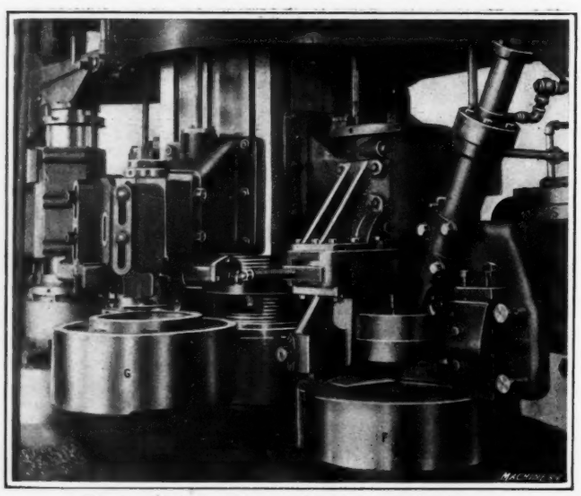


Fig. 6. First Operation performed at Station No. 3

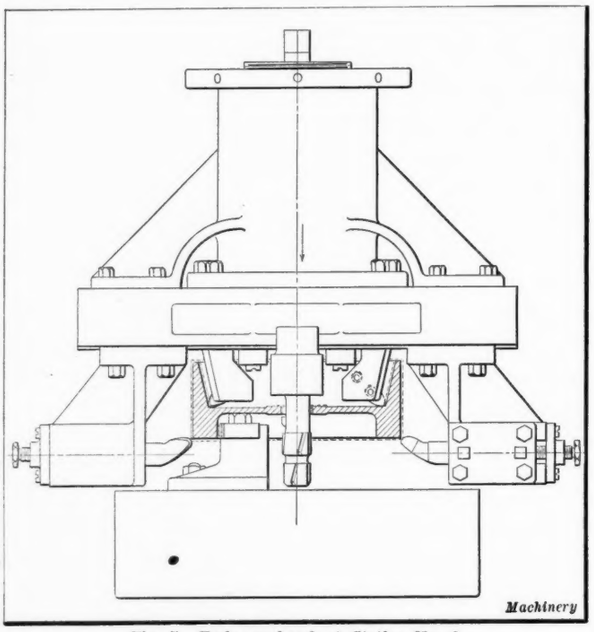


Fig. 7. Tools employed at Station No. 3

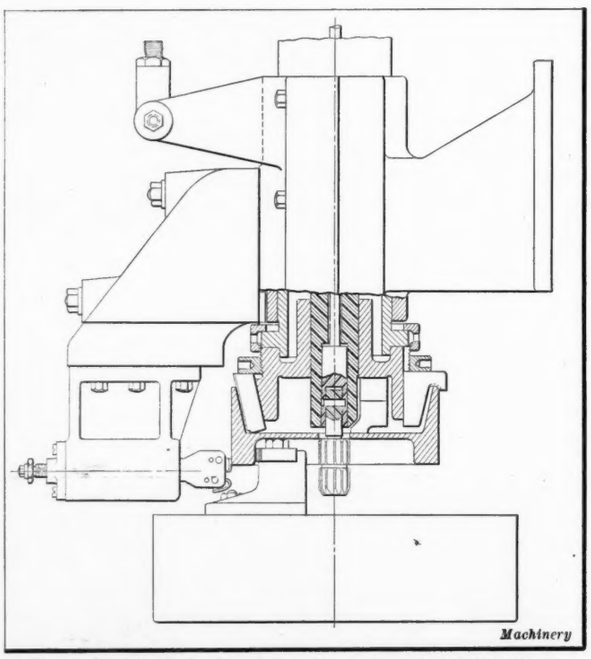


Fig. 8. Tools used for Second Operation performed at Station No. 5

E. K. H.

* * *

The offices and exhibits of the American Museum of Safety have been moved from the Engineering Societies Bldg., 29 West 39th St., New York City, to 16-18 West 24th St., New York City. The new premises were formally opened to the public May 4. They are on the ground floor and afford much better facilities for showing the exhibits than the old quarters. The public is invited to inspect the museum and see the devices shown for protecting life and limb in industrial occupations. Dr. William H. Tolman is the director.

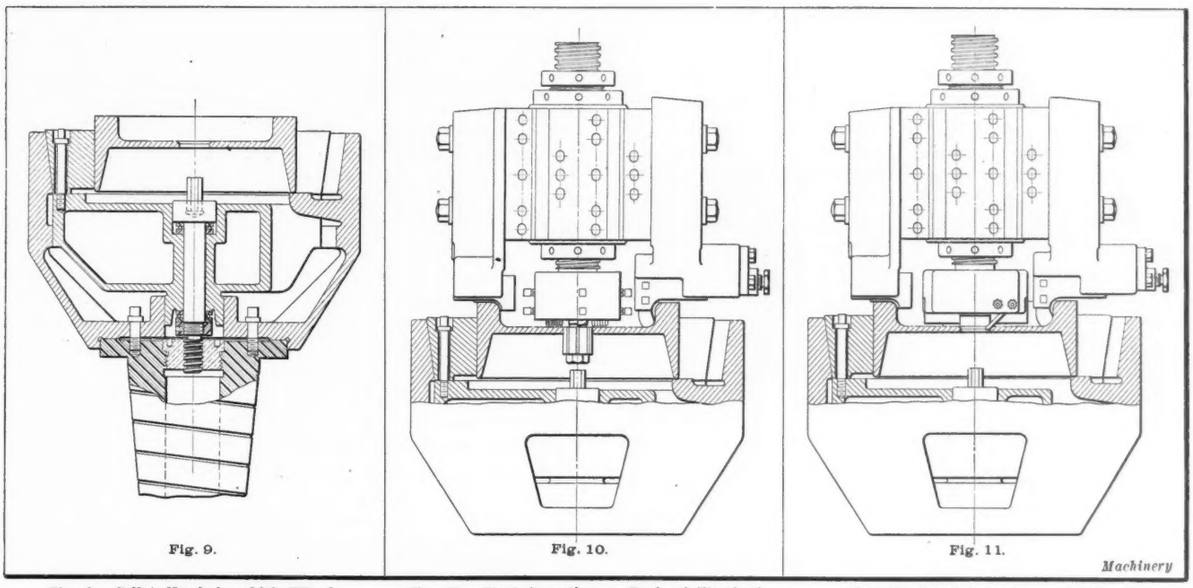


Fig. 9. Collet Chuck in which Wheel is re-set for Final Operations

Fig. 10. First Operation on Back of Flywheel performed at Station No. 4

Fig. 11. Final Operation on Back of Flywheel performed at Station No. 6

A USEFUL FILING SYSTEM

BY HENRY R. GILSON*

In the design and development of machinery it has been the writer's custom for a number of years to preserve all calculations, sketches, and suggestions that are made, having them properly dated before they are filed away. For this purpose brown paper folders are used 9¼ by 11¾ inches in size, which have projecting tabs ½ by 4½ inches, on which is written the subject matter of the contents of the folder. These folders are kept properly arranged in a four-drawer vertical filing cabinet. When a new problem in design comes up, the first step is to make sketches of the parts or an assembly drawing of the complete machine, and these drawings are used as a basis in making calculations. Each drawing and each sheet of calculations are marked with the date on which they were made, and assembly drawings also have a brief description of the functions of the machine attached to them. As the design of the machine progresses and changes are made from the original, new sketches are made and dated, so that when subsequent reference is made to the file the date will show the design that was ultimately employed.

When the first machine is complete and experimental work started, a careful record is kept of every change that is made and the results of each change are properly noted. Many ideas will present themselves of which crude sketches are made, and these may or may not be adopted; but in any case the drawings are preserved, for if an idea is worth putting on paper it is worth preserving. It may be of value when least expected. All correspondence relating to prices of parts of the machine, and the results of all physical, electrical, or other tests which were made to determine certain features are also filed, so that when the machine is completed and turned over to the manufacturing end of the business, the folder in the file will contain an accurate chronological record of the various steps in its invention and development. The advantages of this method are obvious, for if the experimental work extends over a long period of time reference to the records preserved in the file prevents the same change being duplicated. This record also furnishes data which enables any engineer to continue the development intelligently should the necessity arise for so doing. And if at any time a larger or smaller machine of the same type is to be made, a complete set of data on the original machine is at hand, which is of great value for purpose of reference. The value of such a file of information in determining priority of invention in patent litigation has also been demonstrated in certain cases.

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FREAK ADVERTISEMENTS

BY W. F. S.

Manufacturers are often tempted to run "freak" advertisements in the hope of attracting attention. It might interest such advertisers to know that publicity experts are unanimous in condemning this kind of advertising. The principal argument against this practice is its utter lack of dignity. In preparing advertising copy don't arrange pictures upside down or entire advertisements upside down; and don't run advertisments the wrong way of the page unless it is absolutely necessary. Avoid the use of ugly or foolish illustrations. It is all right and generally good practice to "ring in" a little humor once in a while, but don't carry it too far. Nothing is more effective in advertising than the use of good illustrations which show the product you are selling as clearly as possible. Such illustrations are best used in connection with a description that is made as terse and interesting as possible. Make your advertisement one that will sell the product on its merits, and not one that merely attracts attention. Freak advertisements may catch the reader's eye, but it is doubtful if they help in selling.

* * *

The Commission on Industrial Relations, in its first annual report to Congress, deals with the subject of industrial unrest and gives the following reasons for the unrest in labor circles, as seen by the employers and by the employes.

Reasons Given by the Employers

Normal and healthy desire for better living conditions.

Misunderstanding and prejudice; lack of conception that interests of both labor and capital are identical.

Agitation by politicians and irresponsible agitators.

Unemployment.

Unreasonable demands arising from strength of organization.

Labor leaders who stir up trouble to keep themselves in office and to graft on employers.

Inefficiency of workers, resulting in ever-increasing cost of living.

Rapidly-increasing complexity of industry.

Sudden transition of a large number of foreigners from repression to freedom, which makes them an easy prey to labor agitators.

Universal craze to get rich quickly. Decay of old ideas of honesty and thrift. Misinformation in newspapers.

Too much organization for combative purposes, instead of for cooperation.

Violence in labor troubles; sympathetic strikes; boycotting and picketing. Meddlesome and burdensome legislation.

The "closed shop," which makes for labor monopoly; financial irresponsibility of labor unions.

Reasons Given by the Employes

Normal and healthy desire for better living conditions.

Protest against low wages, long hours, and unsanitary and dangerous conditions existing in many industries.

Demand for industrial democracy and revolt against the suppression of organization.

Unemployment.

Unjust distribution of the products of industry.

Unjust attitude of police and courts.

One law for the rich, another for the poor.

Immigration, and the consequent over-supply of labor.

Disregard of grievances.

Unfair competition from prison and other exploited labor.

The rapid pace of modern industry.

Arbitrary discharge of employes.

Black-listing of individual employes.

Exploitation of women and children in industry.

Promotion of violence by the use of "gunmen," spies, and provokers hired by employers.

Attempt to destroy unionism by the pretence of the "open shop."

Monopolization of land and natural resources.

Suppression of free speech and right of peaceful assembly.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Implied Warranty of Fitness of Machine for Particular Use

(Federal.) Where automatic nut-tapping machines, sold by defendant to plaintiff, had been on the market a comparatively short time, plaintiff had never seen or had an opportunity to inspect such a machine, and defendant's circulars stated that they would automatically tap hot or cold pressed nuts and any style of thread or pitch in hexagon or square nuts of iron, steel, brass, or any usual material from which nuts were made, and directed that samples of blank and tapped nuts should accompany inquiries, and the machines were purchased for use on the kind of stock regularly used by plaintiff, with defendant's knowledge of such intended use, there was an implied warranty that they would suitably work such stock; the rule that, when a known, described, and definite article is ordered and supplied, there is no warranty that it shall answer the particular purpose intended by the buyer, though stated by him, did not apply, and it was error for the lower court to charge that defendant did not warrant that the machines were fit for any particular purpose, or for tapping any special kind of nuts, that plaintiff could recover only by showing that the machines were unsuitable to perform the ordinary work which they were made to do in tapping ordinary nuts, and that evidence of plaintiff's reliance upon the alleged warranty should be disregarded.

Where, though a machine was sold on thirty days' trial to enable the buyer to determine whether it would want other similar machines, the buyer was in such urgent need of the machines that, without waiting for the first machine, it asked the seller to build eight machines with the utmost dispatch and ship them to it, and the subject of thirty days' trial was not then or thereafter referred to, it was apparent that the buyer was content to rely upon the situation as disclosed by the seller's circulars and the correspondence with the seller, and not upon a trial of the machines, and instructions on the theory that the sale was a sale on thirty days' trial were improper. *(Kansas City Bolt & Nut Co. v. Rodd, 220 Fed. 751.)*

Patent of Coal Conveying Apparatus Void by the United States Circuit Court of Appeals

(Federal.) The Simmons, Forgham & Bennett patent, for a coal unloading and distributing apparatus for use in ballast burning, held void for prior commercial use of the apparatus in substantially its patented form for more than two years prior to the application.

Where a patented machine was publicly and commercially used for more than two years before the filing of the application, experiments made during that time for the purpose of strengthening and otherwise improving the machine as an operative device must be deemed merely incidental, and not as dominating the character of the use.

Assignment of Patent

(Massachusetts.) The owner of a patent cannot sell and assign his rights thereunder to another, and by means of a suit for infringement of an older and broader patent, subsequently acquired by him and covering the same invention, deprive his assignee of the full benefit of what he purchased. *(United Printing Machinery Co. v. Cross Paper Feeder Co., 220 Fed. 313.)*

Instructions as to Operation of Machinery

(Indiana.) Plaintiff, a common laborer, had on several occasions operated a boom on a steam derrick, holding the rope taut or paying it over the winch head. At these times the rope used was soft and pliable. Plaintiff did not know that it was necessary to make more wraps when a new stiff rope was being used. Held, that it was negligence for the master to direct him to operate the machine with a new rope without giving him instructions.

That the plaintiff attempted to hold the rope with his right hand while he used his left to straighten it does not, though he only had five or six wraps around the winch, show him to be guilty of contributory negligence as a matter of law, in view of the fact that in the past he had been able to hold soft pliable ropes in that manner. *(Indiana Bridge Co. v. Shepp, 108 N. E. 107.)*

Sale of Machinery on Approval

(New Jersey.) On the sale of a machine on approval for one month, and the rejection of the same within the month as not satisfactory, the title to the machine does not pass to the buyer. *(George A. Ohl & Co. v. Barnet Leather Co., 93 A. 714.)*

Assumption of Risk by Machine Operator

(Illinois.) The rule that where an employer promises to repair within a fixed time or within a reasonable time, and neglects to do so, the employe thereafter continuing the employment, and using defective machinery without further complaint and assurance that the same will be repaired, assumes the risk, is not controlling, where no definite time was fixed in which repairs were to be made, and where the employe not only relied on the promise to repair but on the assurance that repairs had been made, and did not discover until after his injury that they had not been made.

An employe presumptively contracts to assume the risk incident to the employment, and he also assumes an "extraordinary risk," which is a risk which may be obviated by the exercise of reasonable care by the employer, if he knows and appreciates the dangers.

An employe, performing dangerous work in obedience to the employer's command does not assume the risk; but he may be guilty of contributory negligence, depending on whether the danger was so great that a person of ordinary prudence would not have incurred it, for "negligence" consists in conduct which common experience or special knowledge of the actor shows to be so likely to produce the result complained of under the circumstances known to him that he is answerable for that result, though it was not certain, intended or foreseen. *(Wheeler v. Chicago & W. I. R. Co., 108 N. E. 332.)*

Machinery Guard Statutes

(Illinois.) Under Illinois laws, providing that all power-driven machinery, including saws, shall be so located as not to be dangerous to employes, or shall be properly enclosed, fenced, or otherwise protected, a circular saw should be guarded to prevent it from throwing off slivers, as it is not the only purpose of the act, as evidenced by "otherwise protected," to prevent actual contact with the saw.

Within Illinois Workmen's compensation act providing that, when the injury to an employe is caused by the intentional omission of the employer to comply with safety regulations, the act shall not affect the civil liability of the employer, the failure to guard a circular saw to prevent it from throwing off slivers, construed to be within the terms of the law and is an "intentional omission."

In the construction of statutes, the intent is to be ascertained, and effect given to it, though it may not be entirely consistent with the strict letter of the statute. *(Forrest v. Roper Furniture Co., 108 N. E. 328.)*

* * *

PROPOSED STANDARDIZATION OF TAP DRILL SIZES BY S. A. E.

The Society of Automobile Engineers has under consideration a subject of considerable importance to manufacturers generally, in the metal working industries. The research division of the standing committee of the S. A. E. has taken up the matter of tap-drill sizes. It is notorious that more taps break than wear out in service; in fact, it is asserted that ninety per cent break instead of wearing out. This not only means heavy tap expense, but what is of greater moment, serious delays in getting new taps, resetting machines and the expense of removing broken taps from the parts being machined. In many cases, it is more costly to remove the broken tap than to scrap the work and to make a new part complete. The belief is that this waste is almost wholly unnecessary and could be avoided by using properly designed taps and specifying correct sizes of tap drills. The research division will investigate the matter with the idea of recommending a tap drill list that can be applied in automobile practice generally, and which will greatly reduce the number of tap drills and taps required.

THE MANUFACTURE OF CHAIN—2

MACHINES AND METHODS USED IN MAKING ELECTRICALLY WELDED CHAIN

BY FRANK H. MAYOH*

IT is the purpose of this article to describe some of the machines and methods used in the manufacture of machine-made chain in which the links are electrically welded. In this work, as in the making of all types of chain, the well-known axiom holds true that a chain is no stronger than its weakest link. Consequently, the chain manufacturer who produces a high-grade product must use material of uniform quality, and the finished chain must be tested to discover any weakness due to improperly welded links, burnt links, or other defects in material or workmanship. In making such tests a load equal to about one-half the ultimate strength of the chain is applied; and as the specified safe working strength of the chain is about one-half the load applied in making the test, it will be seen that the factor of safety allowed is approximately 4. In some cases the specified

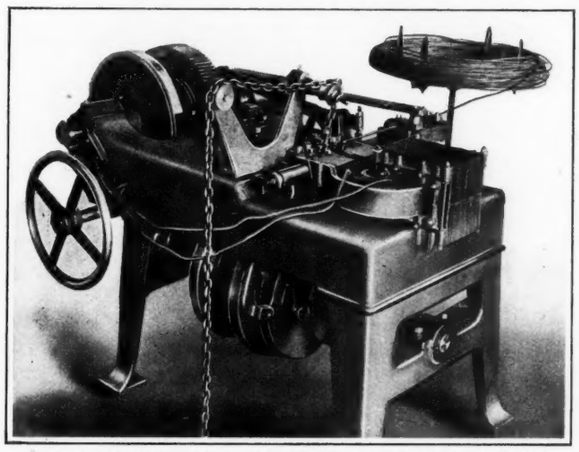

Fig. 1. Machine used for Manufacture of Electrically Welded Plain-link Chain, showing Welding Apparatus

strength of the chain is made one-third the ultimate strength, making the factor of safety only 3.

The Manufacture of Plain-Link Chain

Aside from the provision of the welding apparatus and the necessary mechanism to form the links of the chain, probably the most important requirement of chain making machines is that they be built very rigid so that they can stand up under the strains incident to the constant hammering and twisting which takes place while they are in operation. It is also important for the heat supplied by the weld-

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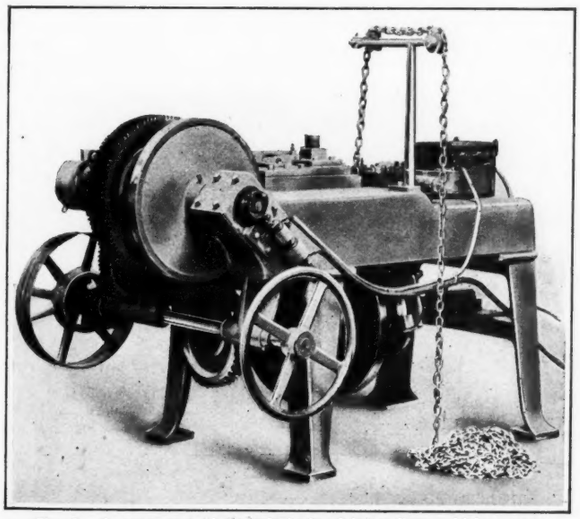


Fig. 2. Arrangement of Cam-shaft for driving Cams which actuate Mechanism of Plain-link Chain Making Machine

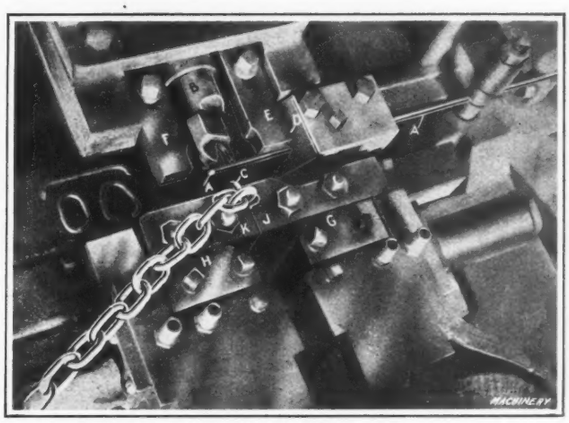


Fig. 3. Link Forming and Welding Mechanisms

ing apparatus to be localized so that it will not affect the different members of the machine. Figs. 1 and 2 illustrate one type of machine used for making plain-link welded chain, and these illustrations show the rigid form of construction that is adopted, both as regards the weight of the machine members and the compact way in which they are mounted on the bed. In operation, this type of machine receives the wire from a coil carried by a reel of the form shown in Fig. 1, straightens it, cuts off a blank of the required length for the size of link that is being made, forms the link and makes a scarf weld, each link being connected with the one previously made, so that a continuous chain making process is attained. When working on ¼-inch wire, the rate of production on this machine is from ten to twelve links per minute.

The steps involved in the manufacture of chain on this

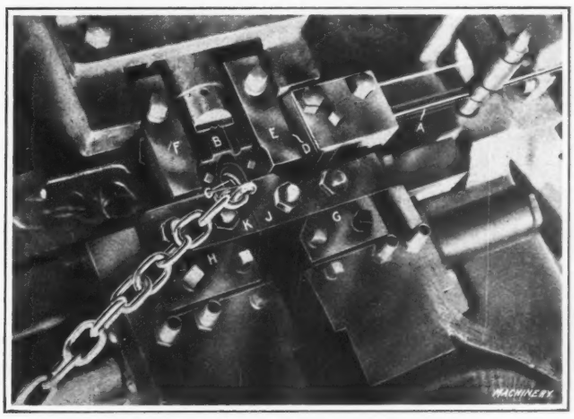


Fig. 4. Mechanism at End of Forming Operation

machine are illustrated in Figs. 3, 4 and 9, which show plan views of the forming and welding mechanisms while in operation. Referring to Fig. 3, the wire *A* is fed up to a stop, which regulates the length of the blank, while the forming plunger *B* is returning from the preceding operation. The arbor about which the links are formed is in the position indicated by *C*, but this arbor is hidden by the chain. As the wire is fed forward, the arbor rises to its upper position, and when it reaches the top of its travel the wire is cut off by a knife carried on the outside of one of the forming slides, the position of the cut-off blade being indicated at *D*. After the blank has been cut off, it is held between the forming slides and the arbor, and the forming slides *E* and *F* continue their forward movement and bend the ends of the blank around the base of the arbor. The arbor then drops to its central position and the forming plunger *B* moves forward and completes bending the blank around the smaller part of

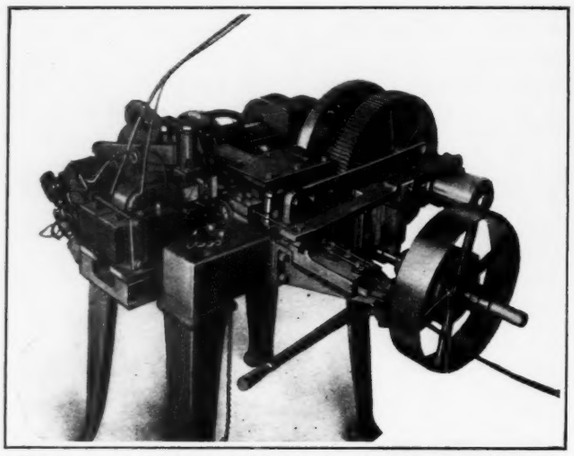


Fig. 5. Form of Wire-straightener used on Machine shown in Fig. 7

the arbor. As the scarfed ends of the blank come together, they pass through the link of the chain which was formed by the previous operation, and are laid over each other ready to be welded. At this stage of the operation the position of the different members of the machine is shown in Fig. 4. The link is still retained in the forming plunger *B* which now makes one-fourth of a revolution to bring the link into position for welding, and at the same time is advanced to the welding jaws *G* and *H* where the link is electrically welded. Before the plunger moves forward to the welding jaws, the arbor *C* must drop to its lowest position, in order to free the link.

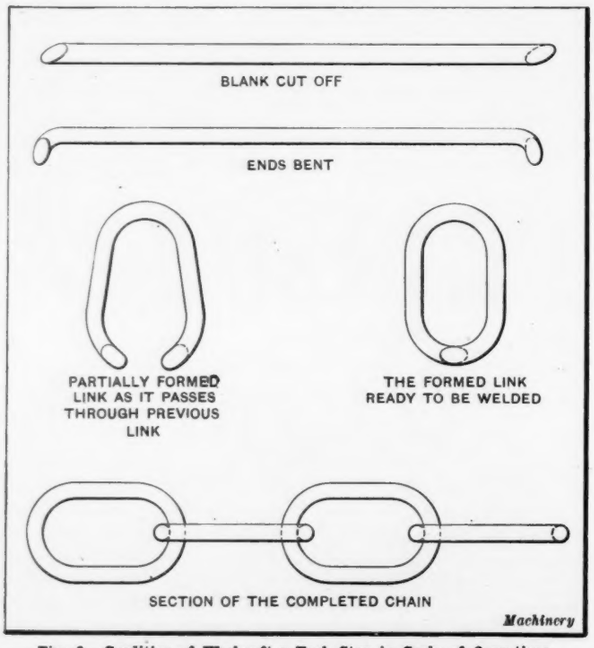

BLANK CUT OFF
ENDS BENT
PARTIALLY FORMED LINK AS IT PASSES THROUGH PREVIOUS LINK
THE FORMED LINK READY TO BE WELDED
SECTION OF THE COMPLETED CHAIN
Machinery

Fig. 6. Condition of Work after Each Step in Cycle of Operations

In the manufacture of electrically welded chain, the speed of production is limited by the time required for welding the links, as the various forming operations require very little time. After each link is welded it is drawn back to the trimming jaws *J* and *K*. In making the weld there is generally a surplus amount of metal left at the joint and while the link is still hot it is drawn back to the trimming jaws which consist of a pair of dies shaped to press the joint into the required form. While this final operation is being performed, the blank for the next link is being fed into the machine and the forming plunger *B* is moving back. During this backward motion, the plunger turns through one-quarter revolution in order to return to its original position. It will be remembered that the plunger *B* made a quarter turn during the operation of producing the link, which was for the purpose of having the finished link still held by the trimming jaws *J* and *K* in position to have the next link passed through it. In order to avoid twisting the chain into kinks, the plunger *B* is arranged to turn alternately through a quarter revolution in the right- and left-hand directions. The operations of the various members of the machine are controlled by cams carried on a camshaft beneath the bed, this shaft being shown in Figs. 1 and 2. The camshaft runs at one-half the speed of the main driving shaft, the drive being through a train of spur gears and a worm and worm-wheel.

The preceding description of the method of producing chain on this type of machine may be briefly summarized as follows: (1) The wire is fed through to the stop; (2) the blank is cut off and has its ends bent by the side forming jaws *E* and *F;* (3) the forming of the link is completed by the forward movement of the plunger *B*, which closes in the ends of the blank through the preceding link; (4) the plunger *B* turns the link through one-fourth revolution and

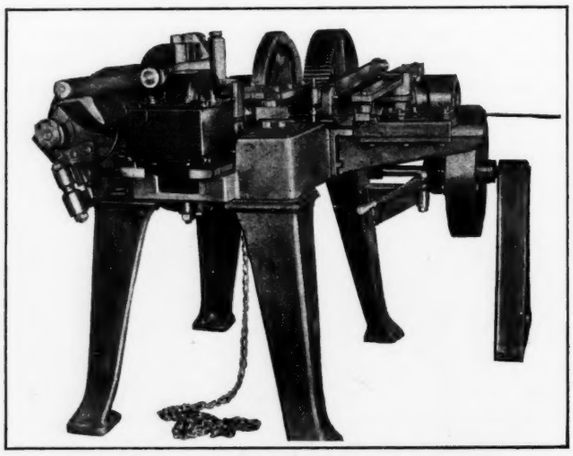


Fig. 7. Machine for Manufacture of Electrically Welded Twisted-link Chain

carries it forward to the welding jaws; and (5) the link is returned to the trimming jaws which grip it and squeeze the excess metal from the weld. The condition of the work after each successive operation is shown in Fig. 6. This sequence of operations is repeated indefinitely until the required length of chain has been produced.

The Manufacture of Twisted-Link Chain

Machines for the manufacture of twisted-link chain, which are equipped with electric welding apparatus, are shown in Figs. 5, 7, and 8. As in the case of the machine used for the manufacture of plain-link chain, the wire is taken from a coil carried by a suitable reel and enters the machine through a straightener which removes all kinks in the wire. The design of the straightener on this machine is somewhat unusual in that it slides backward over the wire while the wire is held by a clamp on the machine. Those who are familiar with

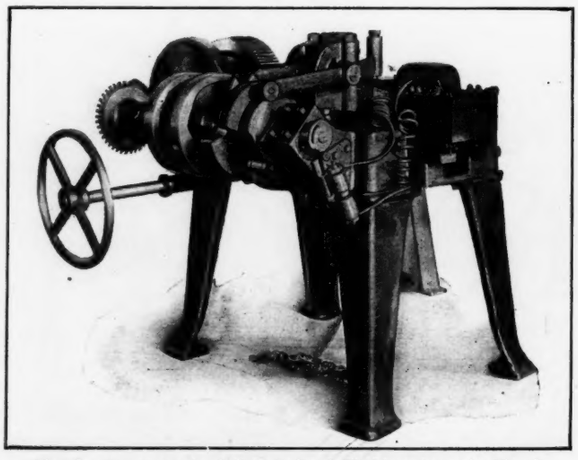


Fig. 8. Arrangement of Cam-shaft of Machine shown in Fig. 7

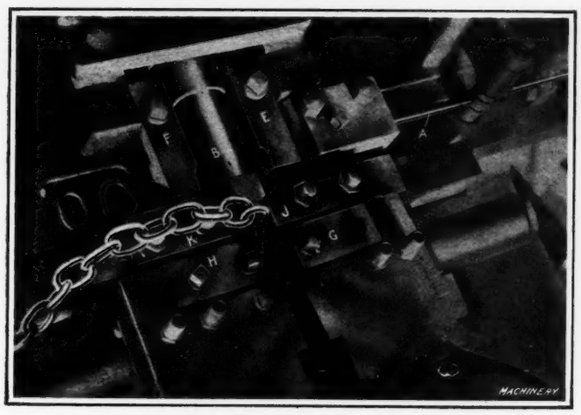


Fig. 9. Position of Mechanism shown in Fig. 4 after Welding Operation

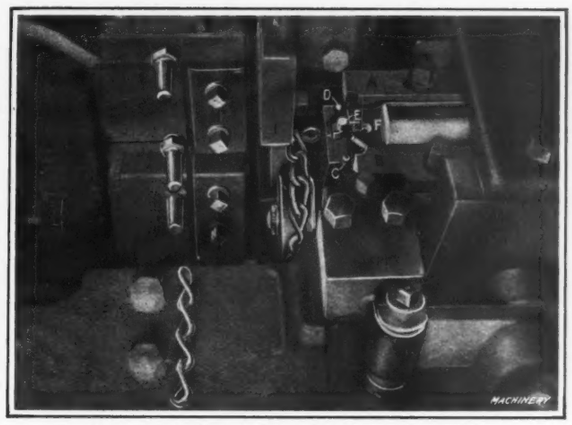


Fig. 10. Starting Point in making a Twisted Link

wire forming machinery will recall that in most wire straighteners the wire is pulled through the straightener. A good view of the wire straightener is shown in Figs. 5 and 7.

In describing the operation of this machine reference is made to Figs. 10 to 14, inclusive. The wire is first fed forward and cut off preparatory to having the ends of the blank bent by the auxiliary forming slides *A* and *B* which act in conjunction with the two pins *C* and *D* on the extreme ends of arbor support, Fig. 10. After this has been done the arbor *E* moves to its second position in front of the forming plunger *F*, which then moves forward to complete forming the link as shown at *G* in Fig. 11. In the course of this forming operation the scarfed ends of the wire are lapped over each other, the ends of the link being closed in through the link which was produced during the preceding cycle of operations. The link is now ready to be welded, and in order to convey it to the welding dies, the arbor *E* drops down to allow the plunger *F* to carry the link forward to the welding dies *H*. In order to provide the necessary clearance, the trimming dies *I* have also opened. As the plunger *F* moves forward it turns through a quarter revolution to bring the link into the welding position; and after the link has been welded, the plunger *F* moves back conveying the link to the trimming dies *I* where the weld is shaped to the required form. These trimming dies grip the link as shown in Fig. 13 and the plunger *F* still retains its grip on the end of the link while it rotates through one-fourth revolution, thus producing the required twist in the link, which is the final operation of the cycle. The plunger *F* now releases its hold and moves back, as shown in Fig. 14, until it reaches its position ready for the beginning of the succeeding cycle of operations, this position of plunger *F* being shown in Fig. 10. The finished link is still held in the trimming dies ready to have the next link passed through it. The operation of the forming plunger on this machine is controlled by a cam on the main driving shaft, and the rotation of the plunger is effected by a segment

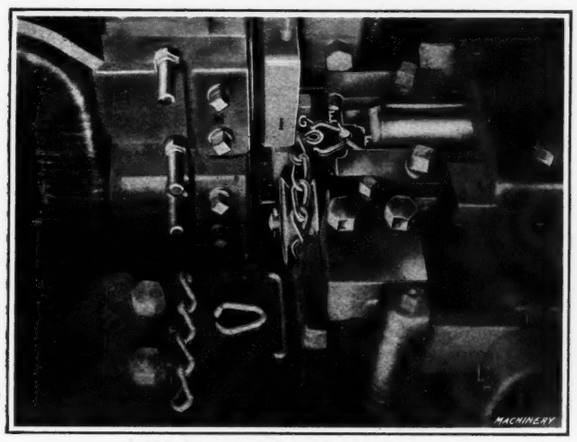


Fig. 11. Completing Bending of Link

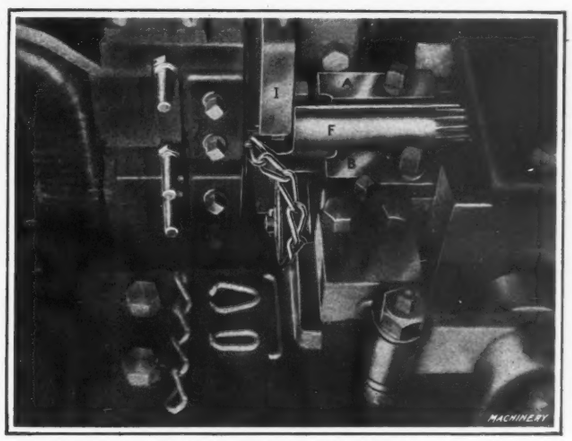


Fig. 12. Welding Joint of Link

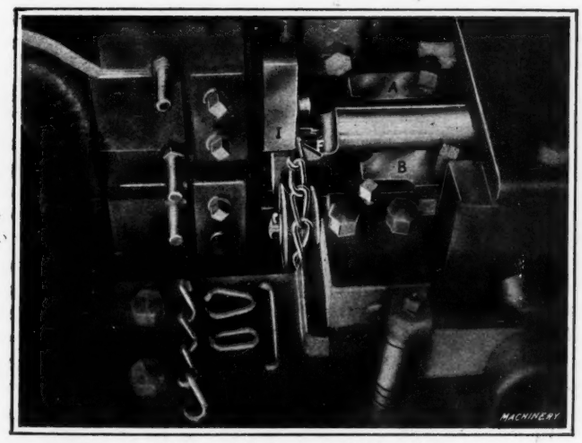


Fig. 13. Trimming and twisting Link

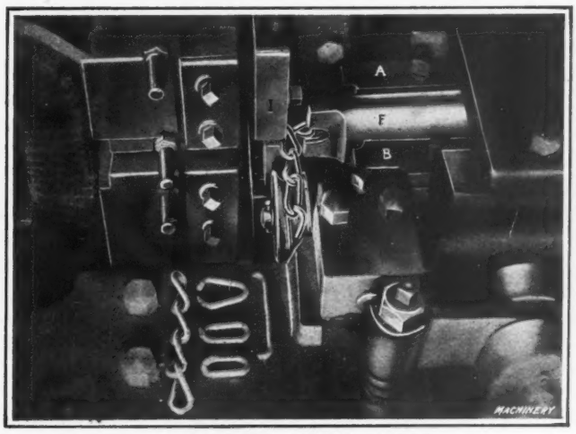


Fig. 14. Return of Bending Plunger

gear which meshes with teeth cut in the plunger; these teeth can be seen in Fig. 12.

The preceding description of the cycle of operations involved in the manufacture of twisted chain on the machine shown in Figs. 5, 7, and 8 may be briefly summarized as follows: (1) Feed the wire through to stop; (2) cut off the blank; (3) bend the ends of the blank; (4) complete forming the link around the arbor, interlocking the link with the adjacent finished link in so doing; (5) weld the joint; (6) trim the joint; (7) twist the link and return the mechanism into position for starting the next cycle of operations. The condition of the work after each successive operation of this cycle is shown in Fig. 15. The two types of chain which have been described constitute the bulk of the chain produced on automatic machines equipped with electric welding apparatus. These are the two types of chain which are filling a great majority of the purposes for which chain is employed. The links are of uniform shape, size, and strength.

A large number of rings are used in connection with chains, and Fig. 16 shows a machine employed for forming and welding rings for this purpose. As regards the principle on which it operates, this machine is essentially the same as the chain making machine employed in the manufacture of plain chain except that different tools are employed. The operations employed in the manufacture of rings on this machine are as follows: The wire is fed forward to a stop; the blank is cut off; and the ends of this blank are bent by auxiliary bending slides. Then the arbor drops down to a lower position, allowing the plunger to come forward and complete the bending operation which brings the scarfed ends of the blank together. The arbor now drops down out of the way and the plunger advances to the welding jaws, at the same time making a quarter turn to bring the ring into the proper position for welding. After the welding operations have been completed, the plunger moves back to the trimming jaws which form the welded joint. While the ring is held in the trimming jaws the plunger moves back to its starting position, and while so doing it must turn back through a quarter revolution. At the same time the arbor moves to its highest position ready to have the next ring formed around it. This machine will make approximately twelve rings per minute when working on ⅜-inch wire.

Needless to say, the perfection of the welds produced is a most important matter in the manufacture of chain. In ordinary welding operations, the metal is sometimes heated beyond the proper welding temperature in order to provide for the loss of heat which takes place during the time which must elapse between transferring the work from the forge to the anvil. This affords an opportunity for an oxide scale to form on the metal, which may result in the production of a poor weld. But in electric welding, the heating and welding of the work take place simultaneously, so that the chance of oxidation is practically eliminated, with the result that the likelihood of producing defective welds is greatly reduced.

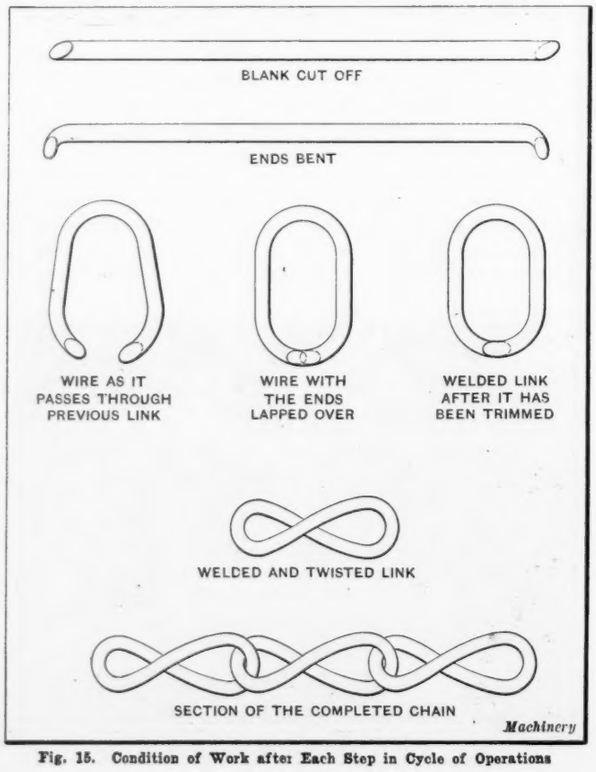

BLANK CUT OFF
ENDS BENT
WIRE AS IT PASSES THROUGH PREVIOUS LINK
WIRE WITH THE ENDS LAPPED OVER
WELDED LINK AFTER IT HAS BEEN TRIMMED
WELDED AND TWISTED LINK
SECTION OF THE COMPLETED CHAIN
Machinery

Fig. 15. Condition of Work after Each Step in Cycle of Operations

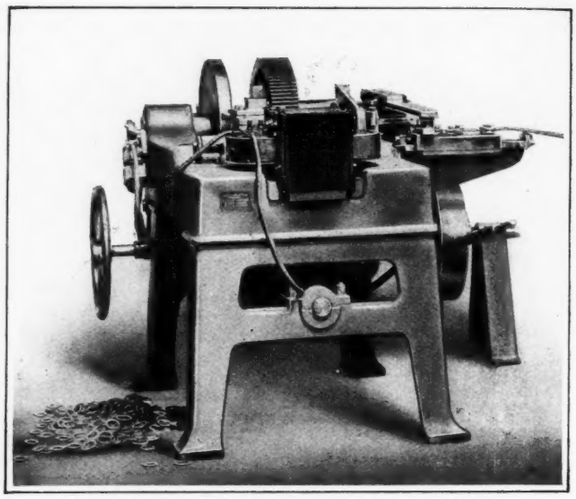


Fig. 16. Machine for Use in Manufacture of Electrically Welded Rings

* * *

THE FUEL VALUE OF WOOD

The fuel value of two pounds of wood is roughly equivalent to that of one pound of coal. This is given as the result of certain calculations now being made in the forest service laboratory, which show also about how many cords of certain kinds of wood are required to obtain an amount of heat equal to that in a ton of coal. Certain kinds of wood, such as hickory, oak, beech, birch, hard maple, ash, elm, locust, longleaf pine, and cherry, have fairly high heat values, and only one cord of seasoned wood of these species is required to equal one ton of good coal. It takes one-and-a-half cord of short-leaf pine, hemlock, red gum, Douglas fir, sycamore, and soft maple to equal a ton of coal, and two cords of cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce, and white pine. Equal weights of dry, non-resinous woods, however, are said to have practically the same heat value, regardless of species, and as a consequence it can be stated as a general proposition that the heavier the wood the more heat to the cord. Weight for weight, however, there is very little difference between various species; the average heat for all that have been calculated is 4600 calories, or heat units, per kilogram. A kilogram of resin will develop 9400 heat units, or about twice the average for wood. As a consequence, resinous woods have a greater heat value per pound than non-resinous woods, and this increased value varies, of course, with the resin content.

* * *

The Allied Machinery Co. of America, 55 Wall St., New York City, alleges that an individual representing himself as Frederick H. Brokaw, Jr., or Frederick L. Bond, is posing as a representative of the Allied Machinery Co. of America and endeavoring to obtain loans from machine tool builders throughout the country. His alleged method of operation is to telephone, saying that he has been robbed of his funds and needs from $50 to $100 for traveling expenses to New York City to catch a steamer or to keep an appointment in Chicago, etc. He has also traveled in Europe, where he is alleged to have victimized several machinery houses. Within the past few months he has used the name of Bond and has endeavored to obtain money from Wellman Seaver Morgan Co. of New York City and the A. J. Smart Mfg. Co., Greenfield, Mass.

PROFILE MILLING AND GRINDING

BY EBEN LEA*

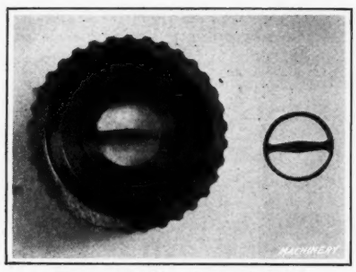


Fig. 1. Profiling Cap and Watch Balance Wheel to be made

On large work, good profile milling can be done without grinding the profiling plates, but on small work, where great accuracy is required, all hardened forms should be carefully ground with a diamond lap. Where a number of these profiling plates have to be made, the following methods will be found to give good results. Suppose it is required to make a plate of the form shown at *A* in Fig. 2. The method of procedure would be as follows: First make a transfer plate *B* in which a hole is drilled to correspond to every hole and small circular arc in the plate *A*. The blank for the plate *A* is then pinned to the transfer plate *B* by means of the center holes, and the ring *C* is placed between them to afford clearance for drilling the holes. The work is clamped to a faceplate and all of the holes are drilled without removing the plate *A* from the transfer plate *B*.

After the drilling has been done, the four segments are cut out of the plate *A* with an end mill. The next step is to make a form *D* in the same way, cutting out the segment with a small end mill. In this connection, it is important to know that in all profiling operations, no mill, lap or guide should ever be used that is larger than the smallest arc in the form, this being especially true for the finishing operations. To avoid under-cutting in the small round corners it is best to use mills with finer teeth than those in general use, the following numbers of teeth having given good results: 0.03 inch diameter, 4 teeth; 0.04, 6 teeth; 0.05 and 0.06, 8 teeth; 0.07, 10 teeth; and 0.08, 12 teeth. A duplicate of form *D* is next made, which is the same in all respects, except that all dimensions are about 0.020 inch smaller. The master form *D* is hardened and then ground on a bench lathe, using the diamond lap *E* for this purpose. The circular arc of the segment is ground in this way, using stops on the rim of the lathe cone pulley to limit the swing of the work in either direction. Then by using the index holes in the back of the

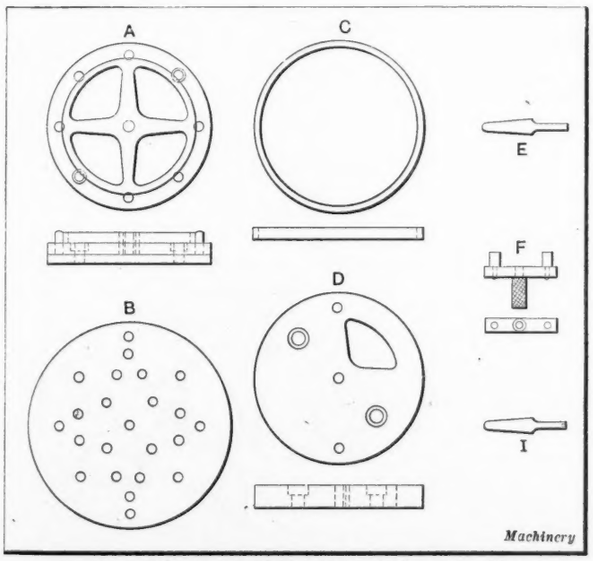


Fig. 2. Profiling Plate, Transfer Plate, Drilling Ring, Master Form, Milling Cutter, Lap and Gage

cone pulley of the bench lathe, the work may be brought into the correct position so that the lap will follow the radial lines of the segment. After the master form has been completed, it is tested with the gage *F* to make sure of its accuracy.

* Address: 225 Center St., Elgin, Ill.

The master form is then used for finishing the second form which, it will be remembered, was made the same except that all dimensions were 0.020 inch smaller. The work is set up on the profiling machine as shown in Fig. 3, with the master form on the lug *G* and the second form on the lug *H*. Using a 3-degree taper mill, the smaller form is finished the same as the master form except that it has tapered sides. After finishing the milling operation, the second form is hardened; and then it is replaced on the machine to be ground with a diamond lap. After finishing in this way, the second form, which is the working form, is ready for use.

For the profiling operation the master form is taken off the machine and the working form placed on the lug *G*, while the plate *A* of Fig. 2 is set up on lug *H*. The milling operation is performed with a straight end mill. It will be seen that there are four holes equally spaced around the periphery of the plate *A*, and these are used for locating the work in the proper position for the four profiling operations which are necessary to complete it. Obviously, the work is turned through a quarter revolution, after each operation to bring it into the correct location relative to the working form on the lug *G*. After the milling operations have been completed, the work is hardened, and then it is returned to the machine and ground to the required finish. The form of mill used is shown at *I*, the smooth cylindrical part following the profile while the fluted teeth do the cutting. For heavier profiling, the forms are made with a 3-degree taper, but the work is milled with a straight cutter on a machine of similar design to the one shown in Fig. 3. This represents the essential features of a profiling machine, which consists of a double slide rest operated by two handles, the motion being transmitted through racks and pinions. The two handles enable the slides to be moved freely in any direction so that the form may be readily followed.

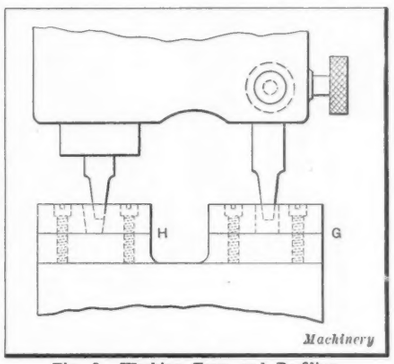


Fig. 3. Working Form and Profiling Plate set up on Machine

Fig. 1 shows a profiling cap and a watch balance wheel which is profiled in this manner. The work is set up on an adapter, on which it is held by the central hole while two square-headed pins that bear against small flats on either side of the work prevent it from turning. The profiling cap covers the adapter, the holes at either side of the cap fitting over the square headed pins at the sides of the work. At the bottom of the fixture on which the work is held, there is a thread which has a lead of 0.04 inch per turn. A pair of lugs on the machine enter slots to engage the thread on the fixture and when the fixture is turned, these lugs act as binding cams to hold the work down while the milling or profiling is being done. Caps made of high-speed steel have good wearing quality.

* * *

ORIGIN OF CIRCULAR SAW

The invention of the circular saw has been attributed to James Murray, of Mansfield, England. Mr. Bale, author of "Woodworking Machinery," states, however, that Murray's claim cannot be substantiated, because it is generally acknowledged that the circular saw originated in Holland in the sixteenth or seventeenth century. Probably the earliest record of its use in England is contained in the patent specifications of Samuel Miller, of Southampton, granted in 1777, in which he claims "an entirely new machine for more expeditiously sawing all kinds of wood, stone and ivory, and the saws used are of circular figure." The motor power employed in this case was a horizontal windmill. In the patent is also claimed an arrangement for bringing the timber up to the saw when in motion.

SNAPSHOTS ON THE ROAD

KEEPING TRADE SECRETS—KINK IN SURFACE GRINDING—POWER REQUIRED FOR DRAWING LARGE SHELLS—EXTRUDING EYELETS—ROUTING CALLS—SPEEDING UP PUNCH PRESSES

THE fallacy in the so-called "trade secret" policy has been frequently pointed out in MACHINERY. The following is an instance which shows up the weakness in the idea that trade secrets can be kept from the "prying public." A short time ago when calling on a prominent machine tool firm, the field service editor was taken through a building where some trade secrets were supposed to be housed. After asking several questions, the nature of the work was told him, but no idea was given as to how it was accomplished. Strolling around, we happened to pass by the door where the work was being done, and the foreman of the department was called out. Instead of closing the door behind him, he stood there with his foot between it and the frame, with the door open, so that the editor could get a good view of the room without going in. The nature of the work being accomplished could be taken in at a glance, and from observation the conclusion was reached that the only reason for keeping this manufacturing method a trade secret was that the firm was ashamed of it. Instead of being up to date, it was accomplished in an out-of-date manner, antiquated, to say the least, by twenty years. This is just another proof of the saying that "In trying to keep ideas in you also keep them out."

"The nature of the work being accomplished could be taken in at a glance"—

A Kink on Surface Grinding

While visiting a large manufacturing establishment, the field editor was shown a little kink in surface grinding which is worth mentioning. Considerable difficulty had been experienced in securing perfectly flat work, and the limits on the part being ground were extremely close. Several months were spent in an endeavor to get the required accuracy without success until a type of magnetic chuck was used for holding the work, in which the work could be disposed along the lines of force or magnetic circuit. This held it without springing out of shape. The wheel used on the job was also provided with eight notches located equidistantly around its periphery and cut at an angle of about 45 degrees to the axis of the wheel spindle. These slots caused the wheel to act as a fan and assisted in keeping the work cool. By this method it was possible to secure limits within 0.0005 inch.

Power Required for Drawing Large Shells

There's a very practical manufacturer of punch presses down near the southern Pennsylvania line. The traveling editors always have most interesting visits in his shop, and almost every time there is an exchange of information that is mutually helpful. On the last trip the field service editor sketched out a set of tools that constituted "a new one" to the press man, but he, in turn, came back with a new idea to the traveling editor.

It was in connection with some of the large press jobs, like drawing up steel barrels, that the "kink" cropped out for determining the power required. The method reminds one of the farmer who found out the number of square feet in his irregularly shaped lot by marking a proportionally small outline on a board, sawing it out and weighing it, and then balancing it with a rectangular board of the same thickness. A little sum in proportion did the rest.

Before this press builder makes a set of tools or determines the press he will use for a particularly heavy stamping or forming job, he makes up a set of tools to produce a part of the same proportions, but on a very much smaller scale—perhaps one-tenth or one-eighth actual size. This specimen set of tools tells him an interesting story. In the first place, the power required for drawing varies as the square of the dimensions of the pieces of work. Then again—just as important—is the knowledge that he gets of the way in which the metal will flow—that is, the amount that can be reduced at each operation, etc. Generally speaking, the characteristics of the operations on the small piece will be the same on the large job.

By following this scheme of making up a reduced size die, a great many blunders are saved to the customer, as well as to the press manufacturer. This practice has been in use for a number of years.

—"the power required for drawing varies as the square of the dimensions of the work"

Extruding Long Eyelets

It was almost five o'clock on an April afternoon when the field service editor struck the office of the manager of an eyelet manufacturing company in southern Massachusetts. The whole office had that appearance of relaxation that comes after the afternoon mail has gone—just before it is time to go home. And the manager, after showing the editor the stunts of the shop, was himself glad to listen to a suggestion.

"I see you use the multiple-plunger press for making your eyelets," said the traveler.

"Yes," said the manager, "and it is the fastest method of producing eyelets that we know of."

"But don't you often get work that can't be done on it—long eyelets, for example?"

"Yes, that's true, and here is a sample," replied the manager, as he thrust his hand into a desk drawer and pulled out a seamless brass tube a quarter inch diameter and an inch long.

"Yes, that's true, and here is a sample"

"Here," said the traveling editor as he rapidly sketched upon the pad, "is a die that will permit you to make that seamless tube one-quarter inch diameter and four inches long in three operations."

The manager scratched his head and replied: "Do you mean to say that I can make that piece in that way?"

"Absolutely," said the editor.

"All right," said Mr. Manager, "I'll have a toolmaker start on this set of tools the first thing in the morning. You've certainly given me an idea that looks practical and I'm glad you came in."

Locating Shops in a Large City

One of the time consuming jobs connected with traveling in a large city is the proper routing of different calls, so they may be covered in the minimum of time. The field service editor has a little wrinkle that greatly facilitates making business calls in a strange city. It is an idea that if followed will help the traveling salesman or the man who has occasion to do business in a strange city.

"With this map before him—"

Briefly, the plan is to lay out upon a pocket map of the city the different calls that are to be made. From this the general direction of the morning or afternoon trip is laid out and the territory systematically covered. The first thing to do is to secure two pieces of cardboard 4 by 8 inches and hinge them along one edge by gluing a small piece of tape or cloth for a hinge. Next, a pocket map may be secured at the hotel news stand, and the business section cut out and pasted upon the cardboard folder just made. Over this a piece of thin writing paper is clipped and the locations of the calls are spotted on this dummy with a lead pencil, adding a word or two for each dot to act as a tracer in identifying it.

With this map before him, the traveling man can cover his territory in the shortest time; and even though he is fairly familiar with the ground, it will save considerable retracing of steps and, moreover, will lead to the formation of regular routes.

"The A. B. C. Electric Co. is running armature disks off at seventy-five strokes per minute"

Speeding up Press Work

Speeding-up is one of the principal fields in which the field service editor can make suggestions that will benefit the shop man. Especially in the case of the isolated shop is the speed likely to be wrong, and it is not noticeable to the man in the shop until some outsider calls it to his attention.

For instance, going through a little electrical shop the other day, the familiar operation of punching armature disks in compound dies was observed. There was nothing unusual about this operation, except the slow speed at which the job was running—perhaps a matter of fifty strokes per minute, when it should have been running at least fifty per cent faster.

"It's none of my business, but why don't you speed up that job a little?" suggested the editor.

"Why, do you think that is slow?" said the superintendent. "We think it's pretty good time here. You know that iron is hard and we don't want to take any chances on that die either. It cost us a pile of money."

"Well," said the field service editor, "here is what I am going by: The A. B. C. Electric Co. is running armature disks off at seventy-five strokes per minute; the Smith & Brown Co. is cutting eighty strokes, and I could name at least a dozen others who are up in that vicinity for speed."

"Well," said the superintendent dubiously, "I'll speed up a little and see how it goes." He will speed up and it will go fine, much to his surprise at first because he will not be accustomed to the higher speed until it becomes more common in his shop.

In visiting many shops, the field service editor unconsciously compares speeds on similar operations in the same way that he compares the quality of the work. Ask the next shop visitor that you have, if he is a mechanical man, what he thinks about the speeds of your operations—you may learn something.

* * *

BLOW-HOLE FILLER

BY WILLIAM WILLIAMS

When turning the face of a large casting the tool frequently breaks through into a hidden blow-hole or other flaw; and although the cavity exposed in this way does not weaken the casting to any appreciable extent, it spoils the appearance of the work and requires it to be discarded. The following describes a blow-hole filler which enables defects of this sort to be remedied without requiring the work to be thrown away. The best plan is to make up a quantity of the filler and keep it on hand ready for use. To do this, secure about 2 pounds of powdered sulphur and 4 pounds of fine graphite; mix these ingredients thoroughly and put the mixture into an iron kettle; then fuse the mixture by heating it over a slow fire. Care must be taken not to overheat while melting, as sulphur may catch fire if it is heated too rapidly. When the mixture has entirely melted it should be stirred for a few minutes to insure a thorough mixing of the sulphur and graphite, after which it is poured into molds and allowed to cool. In its solid form the mixture is hard and possesses a dull metallic luster. When a blow-hole is discovered in a casting, it should first be thoroughly cleaned to remove all grit and dirt, after which a hot soldering iron is used to melt enough of the blow-hole filler to fill the cavity a little more than level. When cool, the surface is smoothed off with a file and emery paper, and will then be scarcely noticeable in the surface of the finished work.

* * *

CRACKS IN CHROME-VANADIUM GEARS

Causes of defects that are obscure often seem perfectly obvious when once discovered. What seemed most mysterious and unexplainable becomes as simple as A B C. The Frost Gear & Machine Co., Jackson, Mich., manufacturer of gear sets for motor cars, was troubled by cracks in chrome-vanadium steel gears. They were ascribed to a variety of causes, but finally were discovered to be due to the use of steam in the forge shop for blowing scale off the dies when forging the blanks. The steam condensed and the water running off the dies collected in little pools into which a red-hot blank would occasionally fall. One side would be quenched while the other remained hot. The unequal shrinkage stresses set up strains that resulted in fractures after the machining and heat-treating operations had been completed. The trouble has led to the substitution of compressed air for steam to clean the forge die.

HOLDER FOR END-MILLS

BY J. P. BROPHY*

In this short article the writer will describe some kinks for holding milling cutters. In the shops of the Cleveland Automatic Machine Co. all kinds of end-mills and angular mills are used, and these ideas have been found very satisfactory in practice. In the holder shown in Fig. 1, the shank *A* is made of tool steel hardened and ground. The drivers shown at *B* are produced by milling the metal at each side. This produces a solid driver and the surface on which the cutter rests is ground after being hardened. The hole into which the stud *C* fits is also ground, making a shank that is perfectly true and that will last indefinitely. The stud *C* is a close fit in the hole in the shank *A* and the large diameter of the stud fits into the hole in the cutter. As the cutter is ground all over, it can readily be seen that by inserting a square piece of stock in the square hole in the stud *C*, using a wrench as shown in the illustration, and drawing the cutters down solidly on the end of the shank *A*, a very rigid construction is afforded. It must be understood in this connection that one end of the cutter has a keyway to fit the drivers *B*. In tests which have been made with this kind of an end-mill holder, it has been found possible to break the cutter to pieces or stall the machine without disturbing the concentricity of the stud *C*. This shows that this is a remarkably efficient holder for end-mills.

The holder shown in Fig. 2 is similar to that illustrated in

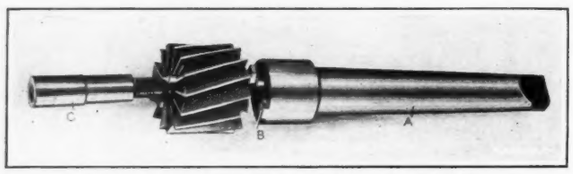


Fig. 1. Efficient Type of Holder for End-mills

Fig. 1, except that this holder is intended for angular mills. The shank *D* is hardened and ground and has a recess in the center to receive the bolt *E*. The shank *D* has a driver on the end similar to that illustrated in Fig. 1. The shank *G* has a keyway at one end, this shank also being made of hardened and ground steel. When using this holder, a keyway is also milled in the cutter *F* and a small hardened key is used for a driver. The shank *G* is tapered at one end to adapt it for carrying angular milling cutters of small diameter. By placing the cutter in position and drawing up the bolt *E*, an extremely rigid holder is provided. This type of holder has been used in the shops of the Cleveland Automatic Machine Co. for years. When using small angular mills, difficulty was experienced in keeping them true, and also from having the arbor become somewhat damaged. The type of holder described has given excellent results. The holders shown in Figs. 1 and 2 are adapted for holding right- or left-hand mills.

The holder shown in Fig. 3 is used exclusively for holding small end-mills. The shank *H* is hardened and ground and provided with a spring collet. The plug *I* fits loosely in the

* Vice-president and General Manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

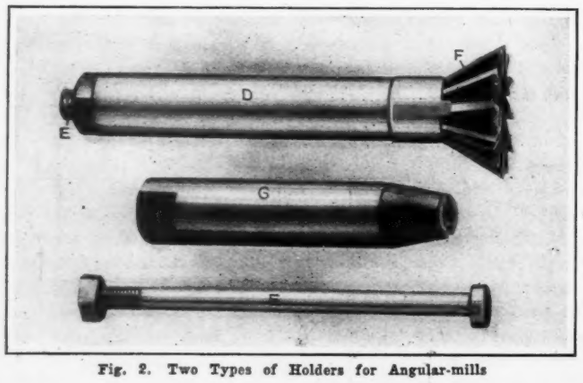


Fig. 2. Two Types of Holders for Angular-mills

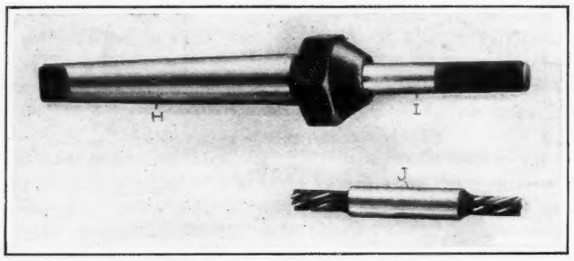


Fig. 3. Holder for Small Sizes of End-mills

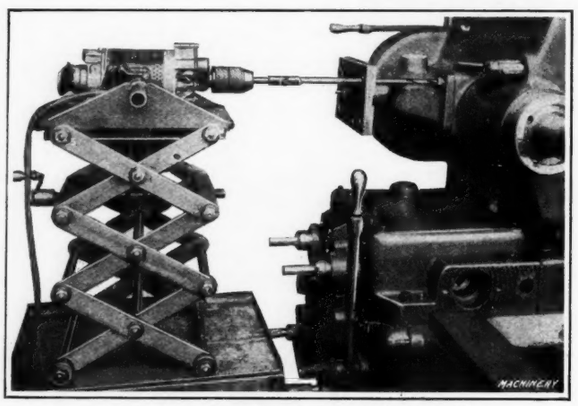
hole in the shank *H* and is merely used for tapping the shank into position in the spindle. If a piece similar to plug *I* were not used for this purpose, the workman would be likely to damage the holder more or less while setting it up in the spindle. The cutter *J* is made double ended to save material; but if made single ended the shank on this cutter should be made about the same length.

* * *

LUCAS ADJUSTABLE SUPPORT FOR ELECTRIC DRILL

Portable electric drills are used extensively in many shops for drilling those holes in work on the erecting floor which cannot be conveniently drilled under the regular drilling machines. The usefulness of these portable tools is often lessened by the lack of suitable means for holding them up to the work; as when drilling horizontally, it is necessary to provide supports in order that the holes drilled shall be square with the work. The supports provided usually consist of blocks, boxes or short pieces of plank picked up in the shop. The collecting of these means time lost, and the resulting pile is perhaps an insecure support. At the best, it is unsightly and not in keeping with efficient shop management.

To meet the need for a convenient, easily adjusted support



Lucas Lazy-tongs Support for Electrical Drill

for the electric drills used in the shop of the Lucas Machine Tool Co., Cleveland, Ohio, the lazy-tongs device shown in the illustration was designed and made. It consists of a cradle for supporting the electric drill, the lazy-tongs extension members and a horizontal adjusting screw. Small casters are provided to facilitate movement about the shop.

Turning the handle moves the cradle up or down, the range of vertical adjustment being about fifteen inches. When the cradle is depressed to the lowest position, a set of four coil springs underneath it is compressed. These were provided to assist in raising the cradle when the lazy-tongs stand at an acute angle with one another that makes the action of the adjusting screw difficult and inefficient. The springs overcome the tendency to stick, and the resistance to elevating is practically uniform throughout the range of adjustment.

* * *

The cost of operating a 900-horsepower Diesel oil engine at the Anheuser-Busch Brewery at St. Louis, Mo., is said by the *Compressed Air Magazine* to total only 0.65 cent per kilowatt hour, of which 0.285 is for fuel oil and 0.275 for labor, while the remainder is distributed over the expense for lubricating oil, water, general supplies, etc.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

ADJUSTABLE AND MULTI-CUTTING TURNING TOOLS

Frank H. Mayoh has made a number of interesting comments in the December, 1914, number of MACHINERY, on my article entitled "Adjustable and Multi-Cutting Turning Tools" which appeared in MACHINERY for February, 1914. Some of the points mentioned are well worth discussion. In the first place I am inclined to think that Mr. Mayoh has misunderstood some of the conditions which governed the work mentioned, a case in point being the method of machining bushings (Fig. 4 in the original article). The description clearly states that "a number of short bushings were to be refinished on the outside" and that they were "of various diameters ranging from 2¼ to 4 inches." From 0.008 to 0.010 inch of stock was left for refinishing and it was important that the exterior and interior should be concentric. Pieces were made up from the bar and were found slightly "out" both in the concentricity and squareness of the ends, so that refinishing was resorted to, a small allowance being left for this purpose. The method described proved both economical and satisfactory, and is in use at the present time by one of the largest machine tool manufacturers in this country. Comparing the lathe method suggested by Mr. Mayoh with the one originally described, I find that his equipment is considerably cheaper, but that the assembling and disassembling would require a much longer time because the work would need to be taken to the arbor press each time a bushing was put on. A reasonable estimate of the time required for finishing a bushing 4 by 3 inches in size by the lathe method would be at least 1½ minute, while the same work on the turret lathe with the equipment mentioned in my article took only about one half this time.

In addition to this, it must be remembered that on the turret lathe the ends of the bushing are squared up while on the lathe this work is not done. Although it may seem a trifle unfair to bring up this point, as it was not mentioned in the original article, the fact remains that it was done; and, therefore, it should be mentioned in any comparison of the two methods. In the suggestion for turret lathe tooling shown in Fig. 2 of Mr. Mayoh's article, I will say that this idea is one which is frequently used in turret lathe work; and while it has a number of advantages, it is not by any means as rigid a construction as that illustrated in the original article, although it is more adaptable to various conditions and is comparatively cheap. It is subject to more or less "chatter" if used for heavy cutting, while the other tool is rigid enough to counteract any such tendency. The piloting of the arbor in the holder on the turret is an excellent idea, but somewhat unnecessary for light cutting. Several examples of piloted arbors were given by the writer in the article on "Arbors for Second Operation Work," in MACHINERY for October, 1913, Figs. 7, 10 and 11.

The point which Mr. Mayoh makes relative to the thrust of the cut coming against the screws instead of on solid metal (Fig. 3 of original article) has several times been mentioned by the writer in connection with the design of cutting tools, and he readily acknowledges that in theory it is much better to have the thrust of the cut taken by the solid metal. In actual practice, however, it is sometimes found advantageous to place the screws in such a position that the operator can easily get at them for adjustment, and except in cases where very heavy cutting was required I have never known trouble to be caused by this arrangement, unless the distance from the supporting screws to the end of the tool was excessive. In the very article criticized, several instances are given in which the thrust is taken by the solid metal and not by the screws, *e.g.*, Figs. 4, 5, 6, 11, 13 and 14; and the point is also mentioned under the head of "Points in Design," No. 7, in the first part of the article, which reads, "Arrange the tool-block in such a way that the thrust of the cut does not come against it; it is much better to have the thrust come on the body of the tool." In the instance mentioned, the cuts taken were comparatively light and the placing of the screws as shown gave greater facilities for adjustment. The overhang of the tools beyond the supporting screws was not great and no chatter was apparent when in use, so that it will be seen that circumstances alter cases; and although the criticism on this point is perfectly logical, the tool was very efficient.

Regarding the criticism on Fig. 6, I am afraid I must differ very strongly from Mr. Mayoh on some of the points mentioned. In the first place the statement is made that the work produced by the tooling mentioned "would not be very accurate because the pilot comes above the work and offers no support to the boring tools." This fact is surely obvious and no claim is made that the piloting of the turning tools has any particular supporting effect on the boring tools, and it is not intended to have any such effect, for no boring tools are used in connection with it. The diameter of the hole to be bored is small in comparison to the diameters turned, and although the drill is combined with the turning tools, the boring is done *separately*, although the boring-bar is piloted in much the same way that Mr. Mayoh suggests, which is ordinary turret lathe practice. The spotting tool is, of course, always used on work of this kind and needs no further comment. The contention that the drill and boring-bar help to steady the turning tools in Fig. 4 of Mr. Mayoh's article is not borne out by practical experience, and any endeavor to make these tools take the place of the pilot on the turning tool would be futile. As a matter of fact the tool suggested would have practically no support except that rendered by its attachment to the turret and would therefore be very unsatisfactory on the work in question. Serious chatter would undoubtedly result, as the work was of alloy

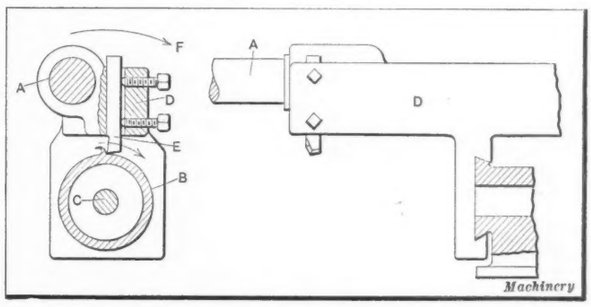


Fig. 1. Diagram showing Effect of Thrust of Cut on Turning Tools

steel, very tough, and having considerable finish allowance, necessitating heavy cutting.

Fig. 1 shows the effect of the thrust of the cut on the turning tools. Holder *D* is secured to the turret face and has a pilot bar *A* which enters a bracket on the spindle cap as illustrated in the original article. The tool *E* is carried by the holder and is at work on the piece *B* which is revolving in the direction indicated by the arrow. Let us suppose there is no pilot bar at *A* and that we are depending for rigidity on a boring-bar *C* piloted in a bushing in the chuck and on the support offered by the turret. It is evident that the thrust of the cut tends to carry the holder in the direction of the arrow *F*, pivoting on the pilot *C*, which does not help matters in the least except that it steadies the work in its relation to the boring tool, but has no useful effect on the turning tool above it. It is a matter of leverage, pure and simple. If, however, we add the pilot *A* to the construction, it immediately counteracts any tendency of the holder to twist in the direction *F;* and as the support is further away radially from the center of the work than the tool is, the support offered is much more efficient. The construction advocated by Mr.

Mayoh is almost identical with that of Fig. 3 in the original article except that the tool-block is on the other side. The conditions governing the two pieces of work were absolutely unlike, for in one case the cuts were light and in the other the amount of stock removed was so great as to require extreme power and rigidity.

The suggestion of a pilot bar mounted in a bracket on the spindle cap (Fig. 5 in Mr. Mayoh's article) has been tried by the writer a number of years ago, and while the scheme has some advantages in the line of manufacture, the rigidity obtained is not as great as if the pilot bar were made integral with the turning tool. Reference to Figs. 2 and 3 of the present article will make clear the advantages of the two methods, and will show why the pilot on the spindle cap does not give as rigid a construction as the other method. The illustrations show a partial plan view of the tools, the holder *V* in Fig. 2 having a tool *B* and a bushing *K* in which the pilot *L* is supported. A bracket *E* on the spindle cap is bored to receive the end *D* of the pilot-bar, which is forced into place. The thrust of the cut takes the direction indicated by the arrow *A* and tends to spring the holder in this direction. This tendency is resisted by the pilot *L* which, being firmly secured to the spindle cap, can bend only from the point *C*, so that vibration (if there is any) will be along the lines *F* and *G*. In the event of extreme pressure being applied to the tool in the direction *A*, the movement of the tool itself would be as great as the vibration of the bar at this point. The other method of construction shown in Fig. 3 of this article has a tool *J* in a holder *N* on the turret with a pilot *O* shouldered and forced into place at *M*. A bushing *Q* in the bracket *P* acts as a guide. In this case, the pressure of the cut tends to pull the tool in the direction *H*, but the shoulder *T* resists the pressure to a great degree, so that it would be found a very difficult matter to spring the bar in the direction shown by the lines *R* and *S*, as the resistance offered by the shoulder is very near that of the tool itself, so there is little likelihood of sufficient vibration being set up to cause any trouble.

The cutting out of the pilot bar in order to clear the gear guard, as noted by Mr. Mayoh, was a very small matter which could have easily been avoided by building a special bracket for the spindle cap and making this high enough so that the entire bar would have cleared the guard. As the bracket used was one which had been made for another job, it was cheaper to use it than to make up a new pattern. The suggestion of placing the pilot bracket in the same position in all cases is hardly practical for the general run of turret lathe work, for in one case a chuck of fairly large diameter may be used in connection with the equipment, necessitating a pilot bar far

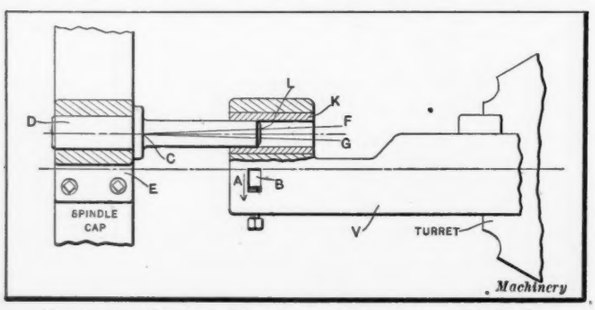


Fig. 2. Shoulder-shank Pilot fitting into Bracket on Spindle Cap

enough from the center of the spindle to clear it, as shown in Fig. 6 of the original article, while in another instance, as Fig. 7, a special holding device may be used which makes it advisable to pilot the tool lower down. The grouping of the tools and the possible necessity for back-rest supports also has an effect on the construction. The criticism which Mr. Mayoh makes on Fig. 10 in the original article, regarding the position of the tool-slide is correct in theory, but a construction such as he advocates would be extremely awkward in practice on account of the difficulty which would be experienced in adjusting the tool. It should further be noted that straps and taper gibs are used in the design and not the dovetail principle mentioned. This point is mentioned in the description of the tool, and a construction of this sort, if properly proportioned in its working parts, is well able to withstand the cutting stresses to which it is subjected.

The use of the adjustable tool-block, shown in Fig. 8 of the original article, does not seem to have been clearly understood by Mr. Mayoh, although its purpose was clearly stated. The purpose of the tool was to handle several different sizes of ring pots and pistons, and in order to avoid excessive overhang when machining small diameters, the tool-block was so constructed that it could be dropped down, carrying the tool with it. It is obvious that on loosening the screws which hold the block, the tool would likewise become loosened

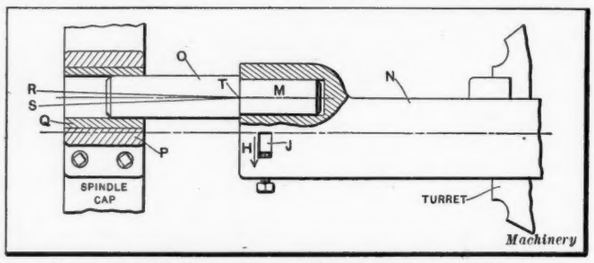


Fig. 3. Straight-shank Pilot guided in Bracket on Spindle Cap

and have a tendency to fall out; but after the block was reset it might not require changing again for a week or perhaps a month, and so it is not apparent how this could be considered a drawback to the adjustable feature. On turret lathe work, adjustments of cutting tools are frequently made by placing a piece of finished work in position and setting the tool down until it strikes the finished surface, which can readily be done in a construction of the type under discussion. It will therefore be seen that this criticism is hardly borne out by the facts of the case. Many of the points mentioned by Mr. Mayoh are of interest, and while some are more valuable from a theoretical point of view than they are in actual practice, all have their value in calling attention to points in construction and design which have seemed faulty. I have endeavored to go into the matters mentioned as thoroughly as possible, without taking up the entire tooling arrangements utilized in connection with the tools described. It is quite possible that Mr. Mayoh's suggestions might have been somewhat modified had he been cognizant of the complete equipment used in the various cases cited.

Bridgeport, Conn. ALBERT A. DOWD

ROUGH-TURNING VS. ROUGH-GRINDING CRANKSHAFTS

In the March number of MACHINERY, J. C. Spence criticizes an article entitled "Some Types of Automobile Crankshaft Lathes," by W. O. Strauss, which appeared in the January number, pertaining to rough-turning crankshafts in preference to rough-grinding. It is my opinion that both writers are somewhat biased in their convictions, as arguments may be advanced in favor of both methods, and I think that neither rule can be applied to all classes of crankshafts. Some cranks may be rough-ground more advantageously than they can be turned, while others may be more profitably rough-turned than rough-ground. I also know of certain cranks on which the best plan is to rough-grind the line bearings and then rough-turn the pins, especially if the crankshaft has a balanced-ball or counterweight that must be machined. On other types of crankshafts where the shop receives good forgings of suitable design, the better plan would be to rough-grind the pins.

There are many points to be considered in determining the most economical method of procedure. One big item is the relative amount of power required in rough-turning as compared with rough-grinding. Other items are the expense of grinding wheels and diamonds used for dressing them, the cleaning of the grinding machine (when used for rough-grinding this seems to require at least double the time that it does when the same machine is used for finishing). These items must be compared with the cost of steel for tools and the up-

keep of machines when the crankshafts are rough-turned. Ten pounds of good tool steel should rough-turn 800 six-cylinder crankshafts—including the machining of the balance weight—to within 0.025 to 0.035 inch in diameter, and 0.005 to 0.008 inch in the width of the finished dimensions. When cranks can be turned within these limits it will pay to rough-turn them. You may rough-grind to within 0.012 to 0.015 inch in diameter, using a full width wheel, which naturally makes finishing the crank a faster operation than when it is rough-turned, but care must be taken that the sides and fillets are true and that the width does not vary when the crank is rough-ground in this manner.

Mr. Spence writes of using up grinding wheels on other work, that have been worn down in rough-grinding crankshafts. Would it not require a considerable amount of such work to make use of these roughing wheels of a standard grade and grain? I have been interested in the production of crankshafts for more than ten years, during which time I have seen more than 300,000 crankshafts produced. These were of various types and designs, and from this experience I believe that the only satisfactory method of determining whether rough-turning or rough-grinding is the better process is to make a careful study of all requirements of an individual job and adopt that method which has the most features to commend it.

Racine, Wis. E. T. CAUSER

STEEL PISTON RINGS

In the March number of MACHINERY, F. W. S. asks for information in regard to the use of steel piston rings for steam engines. When I was engineer on an English steamship several years ago, I had some experience with the Clark & Chapman steel piston rings which were in use on the pistons of the engines that drove the cargo winches. These rings were very satisfactory; we never had any trouble with them, and as both the rings and cylinder were worn to a high polish, they worked very nicely. As nearly as I can remember, the cylinders were about 10 inches bore and the rings of ⅜ inch square section.

I have never seen steel piston rings used in large engines, and cannot say if they would give equally good results. The best way to make a steel piston ring is to roll the ring to a size that is large enough to allow for the spring in the ring plus the stock for machining. Close the ends of the rings together, fasten them and then machine the ring to the size of the cylinder. When made according to this method, the ring will be a perfect fit and have the required amount of spring. The allowance for spring in a steel piston ring should be larger than for a cast-iron ring, a suitable allowance being about 1/32 inch per inch of cylinder diameter.

Hoquiam, Wash. N. W. KAUNITZ

Undoubtedly there are steam engine pistons fitted with cast-iron rings which are giving good service and very little trouble, but I have yet to learn of a case where steel piston rings have proved satisfactory in all respects. I have experimented with steel rings on three occasions and the results obtained were very poor. I am not in a position to say why this was the case, but on each occasion, when experiments were tried with the steel rings, the problem of lubrication was found to be more difficult than was the case where cast-iron rings were used. It seems that the steel rings will not carry a film of oil sufficient to lubricate them properly, and as a result the cylinders are cut and worn unevenly, while there is very little wear in the piston rings.

I have found that large rings ranging from 10 to 25 inches in diameter give much better satisfaction when they are made of Swedish iron than if they were made of steel. The Swedish iron rings are more elastic, more easily fitted, and can be kept lubricated more readily. Owing to the superior lubrication possible, the cutting of the cylinder is practically eliminated, and as a result the Swedish iron rings will outlast steel or cast-iron rings by a considerable margin. A further saving results from the fact that breakage of the Swedish iron rings is practically negligible.

I have never had any experience with the piston rings used on steam hammers, but the success obtained with the Swedish iron rings in other classes of service makes me feel confident that it would be a superior material to steel, owing to the severe shocks to which the piston rings on a steam hammer are subjected. It will be found that Swedish iron is slightly higher in price than steel, but the results obtained appear to more than justify the additional expenditure for material.

Fort Wayne, Ind. H. R. TALMAGE

In reply to the question asked by F. W. S. in the How and Why department of the March number of MACHINERY, I would say that what are known as the Ramsbottom steel piston rings are extensively used in Europe on stationary, marine and locomotive engine pistons. The advantages claimed for these rings are low initial cost, freedom from breakage, lightness and good wearing qualities. They are easily fitted and inserted in the grooves in the piston, four rings usually being employed on a piston, although two rings have been found to give good results. Owing to their lightness and to the method by which they are manufactured, these rings conform readily to an uneven cylinder wall, and even where the supply of lubricant is scanty it is very rare for the cylinders to show any considerable sign of cutting. In this respect, the steel rings show a marked advantage over the cast-iron rings.

These steel piston rings are of the concentric type, the method of manufacture providing the necessary amount of spring. Either of two methods of manufacture may be employed and in each 0.125 inch per foot of cylinder diameter is allowed for the spring in the ring. The first method consists of rolling the ring to the required shape and size in a double set of rolls, rolling sidewise at the same time that the curvature is being formed. This method results in compressing the inside edge of the ring, and gives the required spring. It is necessary to allow the ends of the ring to overlap to get rid of end distortion. After cutting the rings to the required length, they are clamped on an arbor and ground accurately to size.

The other method of manufacture referred to consists of winding up a coil of metal which is cut into individual rings. These rings are then placed in a circular die and pressed to the required shape and size. This may be done by either hydraulic pressure or by rolling, the latter being the more satisfactory method. If, however, F. W. S. only desires to make up one or two sets of rings, he would find it more satisfactory to forge the rings from steel and then turn them to size in a lathe. Very good results could be obtained in this way, although it will be necessary to peen the rings thoroughly on the inside in order to give them the required tension and strength. This should be done before the finishing cuts are taken.

G. M. H.

EARLY ENGINEERING HANDBOOKS

I read with interest the article on early engineering handbooks in the April number of MACHINERY. At the present time, I have in my possession a copy of Grier's "Mechanic's Calculator," published by Thomas Wardle, 15 Minor St., Philadelphia, Pa., and dated 1839. It is evidently of the sixth edition and the preface or introduction is dated "Glasgow, 27th August, 1832."

This "Mechanic's Calculator," 1839 edition, printed in Philadelphia, seems to be earlier than any of those mentioned in the article referred to. The book contains some interesting material, including steel engravings of the steam engine, windmills and water wheels.

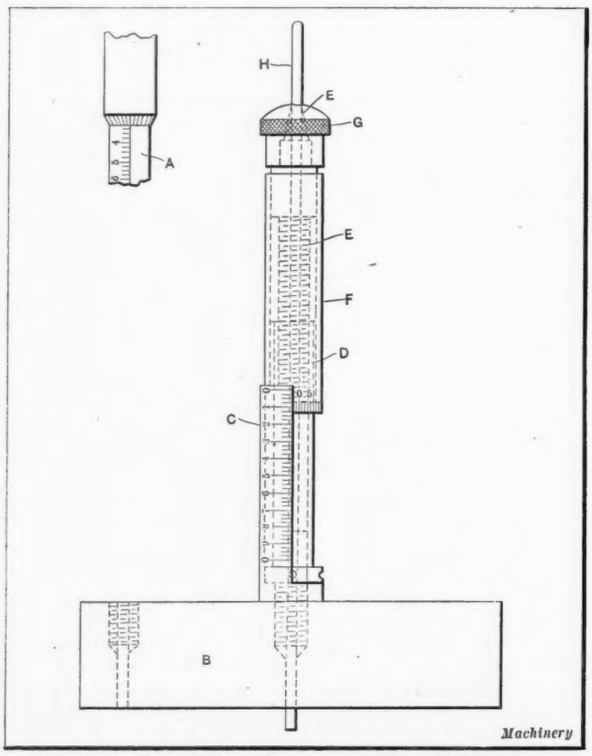
Mount Vernon, N. Y. WARREN L. SMITH

[The work referred to, which was submitted to the editorial department for examination, is a curious compendium of arithmetic, geometry, mechanical drawing, conic sections, mensuration, mechanics, strength of materials, hydrostatics, hydrodynamics, pneumatics, heat, steam engines, steamboats, friction, and machinery in general, concluding with tables of square and cube roots and useful recipes for workmen. It is interesting to compare this old work with

a modern handbook highly specialized, containing in some cases more on one subject alone than is in this whole work. The book, nevertheless, was a good one for its time, and any old-time mechanic who had read it, studied the problems and understood the principles, would have compared very favorably in knowledge of general engineering principles with mechanics of today.—EDITOR.]

EXTERNAL SCALE DEPTH GAGE

The external scale depth gage described herewith is believed to be of sufficient novelty to warrant bringing it to the attention of readers of MACHINERY. The superiority of this design over the usual form of micrometer barrel can be best explained by first referring to the detail of an ordinary micrometer barrel shown at *A*. It will be evident that the figures on a depth gage must read from the top down, and hence as the thimble descends it covers the figure that constitutes the starting point in taking the reading. Thus it will be seen that the figures 1, 2 and 3 of the thimble and barrel shown at *A* are covered; and in taking the reading it is necessary to refer back from the figure 4 to obtain the reading. Although there is no great difficulty in so doing, mistakes are likely to be made.



Micrometer Depth Gage with Scale on Outside of Thimble to facilitate reading

With the external scale all of the figures are always visible, the bottom of the thimble and the right-hand edge of the scale being used in taking the reading. Referring to the illustration, it will be seen that the tool consists of a block *B*, upon which the scale *C* is mounted. The micrometer nut *D* runs over the 40-pitch screw *E*, which is a combination micrometer screw and collet; and the thimble *F* is graduated into twenty-five spaces in the usual way. The nut *G* is for the purpose of binding the collet *E* onto the plunger *H*, which extends down through the block *B* of the depth gage to enable the tool to be used in the ordinary way.

Elgin, Ill. EBEN LEA

TRUING UP CHUCK JAWS

It is hard to see why anyone should attempt to true up the inside gripping faces of chuck jaws with the jaws straining out against a ring, as shown at *A* in Fig. 1, but this is done by many men who consider themselves good mechanics. If the ring were placed as shown at *B*, the conditions would not be so bad; but in order to obtain the most favorable results,

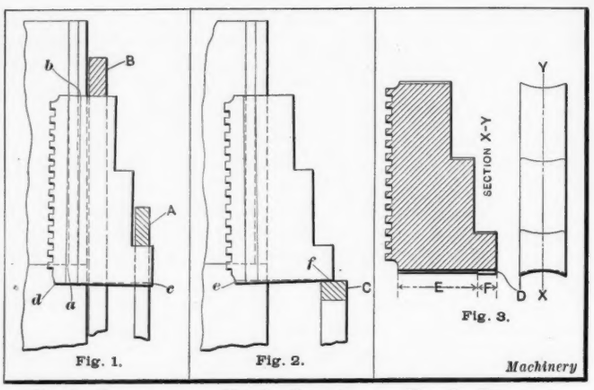


Fig. 1. Incorrect Method of using Setting Ring

Fig. 2. Correct Method of using Setting Ring

Fig. 3. Error produced by not using a Shim in re-setting

the ring should be placed as shown at *C* in Fig. 2, as this places the jaws under the same conditions which exist while they are holding a piece of work. The illustration shows the nature of the error that is introduced when the jaws are trued up with the ring applied as shown at *A* and *B*. With the ring in position *A*, the straining out of the jaws sets them at an angle with the body of the chuck, indicated by *a* and *b*. It makes no difference how new and close fitting the jaws of the chuck may be; there is bound to be a certain amount of error of this nature. And even if we could imagine a chuck with absolutely no play in the bearing surfaces of the jaws, there would still be a tendency for the chuck body to spring. Boring the jaws while in this position results in cutting away more metal at *c* than at *d*, the cut being indicated by the dotted line. When gripping the work with a surface finished in this way, the pressure of the jaws is reversed and a bell-mouthed opening is produced that is shown by the full line in Fig. 2. With the ring set at *B* the tendency to strain the jaws and chuck body out of true is not so great, but there is still likelihood of trouble from this source.

When using a ring in the position shown at *C* in Fig. 2, the jaws are strained open at the outside, and a parallel cut taken from the inside of the gripping surface cuts away more metal at *e* than at *f*. The jaws should be carefully centered with the chuck body and a cut started at *e* that will almost reach the surface when the left-hand side of the ring *C* is reached. The ring is then placed farther in to allow the cut to be completed; and in making this second setting of the ring it should not be placed any farther back than necessary. The ring will have to be increased in size by the use of suitable shims in order to compensate for the metal which has been removed from the chuck jaw by the partially completed cut. If this is not done, the condition shown at *D* in Fig. 3 will result. The surface *E*, which has been bored on a larger radius, will be flatter than the surface *F*. This error will, however, be negligible in most cases.

Turtle Creek, Pa. WILLIAM S. ROWELL

DIES FOR DRAWING CUPS

When drawing sheet steel cups under a power press, there are many points in the construction of the dies, the observance of which will add materially to the quality of the work and the rate at which the parts are produced. It is generally known that the required size of cup and the gage of the metal from which it is to be made, determine the dimensions of the draw-ring. As a rule, however, it is not desirable when redrawing to allow the cup to come in contact with the entire height of the draw-ring, as the frictional resistance which the

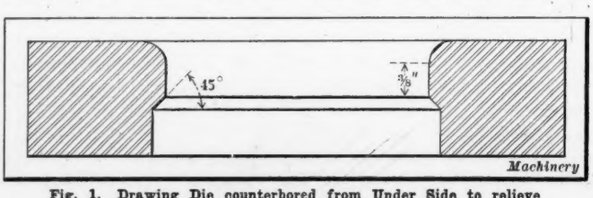


Fig. 1. Drawing Die counterbored from Under Side to relieve Frictional Resistance between Die and Work

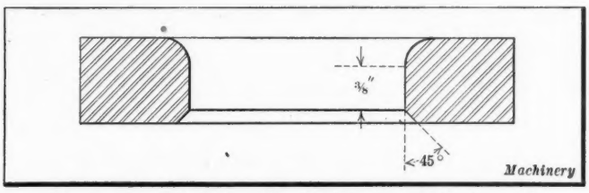


Fig. 2. Die with Under Edge beveled; the Height does not warrant counterboring

ring offers to the passage of the work might result in drawing the wall of the shell too thin. To avoid this and still maintain the necessary height of the ring, I have found it desirable to counterbore the draw-ring from the under side to a diameter about ¼ inch larger than the diameter of the hole in the die. This construction is clearly shown in Fig. 1.

Experience has shown me that ⅜ inch of straight wall is sufficient for the draw-rings used for drawing most forms of cups, but it is not desirable to have a sharp edge at the bottom of the draw-ring. This edge should be beveled off at an angle of 45 degrees, as shown in Fig. 1, to avoid the possibility of chips breaking off, as they are likely to do if the edge is left sharp. Although beveling the edge in this way eliminates the danger of breaking chips from the bottom of the die, it is not always possible to follow this method of procedure, as the sharp edge is sometimes relied upon to strip the shell from the punch. However, this method of stripping is very poor and I personally prefer to use stripper dogs for the purpose. Fig. 2 shows how this method of beveling the under side of the die may be used to advantage even though the height of the die is not sufficient to warrant counterboring.

H. E.

BEVEL CHANGE GEARS

It is a commonly accepted theory that when the number of teeth in one of a pair of bevel gears is changed, the pitch cone angle is changed also, and this necessitates the provision of a new running mate for the gear with a pitch cone angle to conform with the changed angle of the first gear. While this may be quite true in theory, there are times when a great deal of unnecessary expense would be incurred if this rule were followed. Occasionally it is desirable to have a series of change bevel gears, and if the foregoing theory were strictly adhered to it would mean that each change would require two special bevel gears. Fortunately, however, this rule has its exception, as is shown by the following.

It was desired to make a set of bevel pinions having a range of from twenty to forty teeth, increasing by steps of five teeth. This set of pinions was to be used for driving an 80-tooth bevel gear. To avoid making a special 80-tooth gear for each pinion of the set, the following experiment was tried and found to work with entire satisfaction. As previously stated, the pinions were required to have from twenty to forty teeth ranging by intervals of five teeth. The draftsman selected the middle pair of gears, *i. e.*, the 30-80 tooth combination, and figured their face and cutting angles, outside dimensions, etc., in the regular way. Next he drew up the entire set of pinions, giving each pinion the face and cutting angle found correct for the 30-tooth pinion running with the 80-tooth gear. From these drawings, iron patterns were made, from which the pinions were cast, and when these pinions were tried out with the 80-tooth gear, they were found to run satisfactorily with practically no alteration. In one or two cases the patterns were filed up just a little to remove a slight "cramp."

W. J. HAMILTON

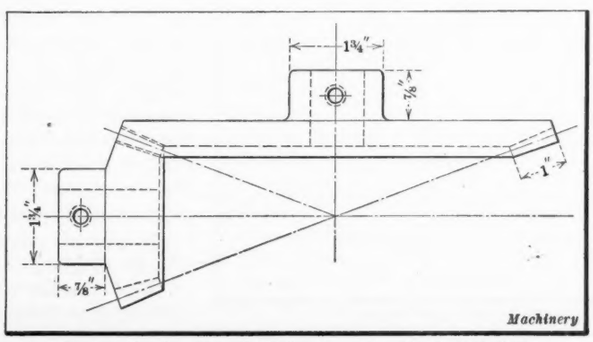
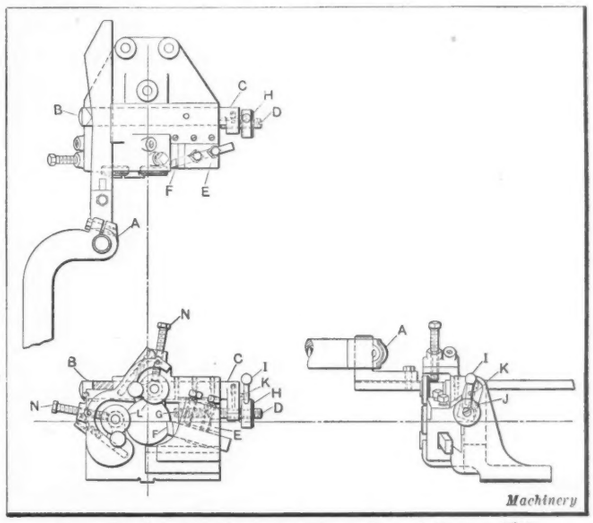


Diagram showing 30-tooth Pinion in mesh with 80-tooth Gear

TAPER-TURNING ATTACHMENT WITH ROLLER BACK-RESTS

The taper-turning attachment illustrated and described herewith was recently designed and built by the Jones & Lamson Machine Co., Springfield, Vt., for turning tapers up to 20 degrees included angle on bar stock. It is made in two sizes, the smaller to take stock from ½ to 2¼ inches in diameter and adapted for use on the 2¼ by 24-inch flat turret lathe; the larger size takes stock from ½ inch to 3 inches in diameter and is adapted for use on the 3 by 36-inch flat turret lathe. To turn any taper within the capacity of the attachment, a templet is accurately ground to the required taper. This templet is clamped into the end of an arm extending from the head of the lathe, in such a way that it is rigidly though adjustably held, as shown at *A*. The templet is adjusted to the proper height from the turret, and runs freely in a groove in the base casting of the attachment which is securely bolted to the turret.



Taper Turning Attachment for Use on Jones & Lamson Flat Turret Lathe

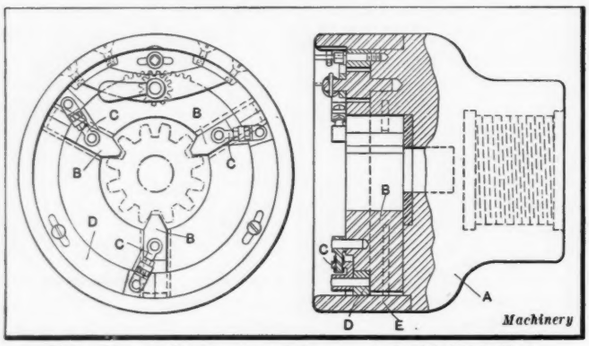
As the turret is fed toward the chuck, the templet actuates a follower which passes through the base of the attachment. This follower is notched at the end *B* to receive the templet, while the other end *C* is off-set to carry the screw *D*. The screw *D* engages the sliding block *E* which carries the cutting tool *F*, the sliding block being held securely against the screw by a spring *G*. In this way the pressure of the templet always holds the tool against the work while the action of the spring prevents the tool from digging in. The screw *D* provides an adjustment for the tool and block; and when the tool is properly adjusted to the work, the nut *H* on the screw *D* is turned until the handle *I* strikes the stop-pin *K*, after which the binder screw *J* is set. In this way a rapid method is provided of relieving the tool while drawing the carriage back from the chuck. A slight turn of the handle *I* relieves the tool; and by moving the handle back against the stop-pin, the tool is brought back into the operating position.

The roller back-rests or steadyrests shown at *L* are mounted on swinging roll carriers, and are easily adjusted to run on any diameter of stock by adjusting the screws *N*. The rolls are designed to run on the straight stock in advance of the cutting tool and do not follow the taper that is being cut. The direct sliding movement of the tool-block in its dovetail bearings and the rigid backing provided by the roller rests work together to insure the production of a smooth taper, the accuracy of which is limited only by the accuracy of the templet.

Springfield, Vt. C. R. RANNEY

GEAR GRINDING FIXTURE

It is the purpose of this article to describe a fixture for grinding the bearing holes in gears after they have been hardened, the fixture providing for having the hole central with the pitch circle. It consists of a cast-iron body *A* which is threaded to screw onto the spindle of the machine on which



Fixture for grinding Bearing of Gears central with Pitch Circle

the fixture is used. The face has three slots machined in it to receive the jaws *B*, these jaws being hardened and ground. The jaws are operated by adjustable links *C* which, in turn, are connected to the ring *D*. By rotating the ring *D*, the links *C* actuate the jaws *B* so that the gear is centered ready to be ground. The ring *E*, which surrounds the body of the chuck, is pressed into place, after the body has been machined where required.

Detroit, Mich. C. A. SIEWECK

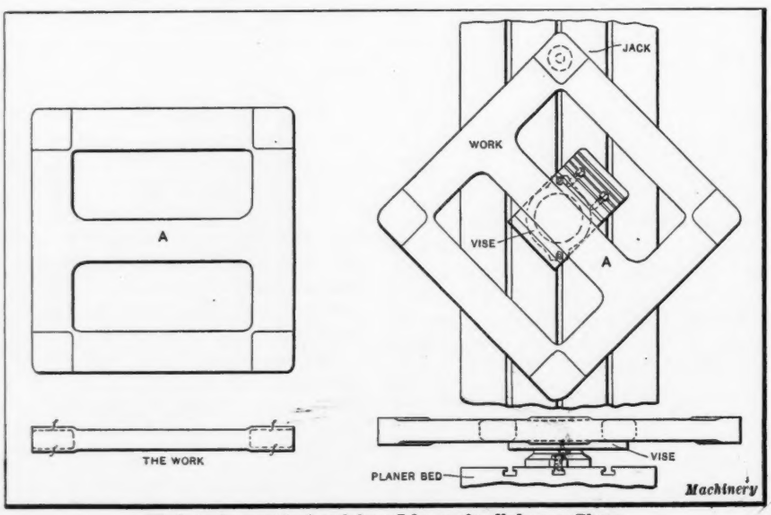
AN UNUSUAL PLANER JOB

After finishing the design of a machine which we were going to build, I found that the baseplate was too large to be finished in the usual way on any of our planers or milling machines. As shown in the illustration, this plate was 40 inches square and had a 5-inch square boss at each corner, which had to be finished on both sides. It was required to have the faces of these bosses as nearly parallel as possible, and on that account it was important to finish the first side of the base at a single setting.

After giving the matter considerable thought, we hit upon the idea of clamping the cross-bar *A* in a large swivel vise mounted on the planer table. After truing up the four corners of the work as nearly as possible with a surface gage, the work was swung around so that two of the corners came approximately over the center of the planer table, after which the swivel head of the vise was clamped. Set up in this way, ample room was provided to run the front of the work far enough under the cross-rail to permit planing the surface of the boss. In this connection it should be mentioned that a jack was placed under the corner of the work while it was being planed. By swiveling the vise, the other three corners were successively brought into position for planing.

After the four bosses on one side of the plate had been finished in this way, the work was taken out of the vise, turned over and replaced with the finished side down, this finished side then being used to true the work up properly. The jack was brought up under the first corner to be planed so that it just touched the work, after which the screw was fastened and the jack left at that height. As each corner was brought into position for planing, the jack was placed under it to afford the necessary support. Very satisfactory results were obtained in this way, and when the plate was finished it was found that the corners did not vary over 0.002 inch, this error being corrected by scraping.

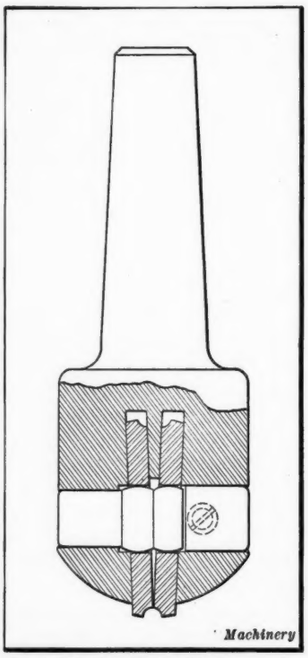
Middletown, Conn. E. M. BIDWELL



Work to be machined and how Job was handled on a Planer

RIVET SPINNING TOOL WITH IMPROVED BEARING FOR ROLL PIVOT

Rivet spinning tools, as commonly made, have two rolls set at a slight angle with each other but both turning on the same pivot. This construction forms a very poor bearing for the rolls, as the hole in the roll must be larger than the pin, and therefore can only touch the pin at one point—the face of the roll. If the hole is tapered to bring its lower side in line with the pin, greater side play is produced in the hole which is already too large, and the roll is subjected to a twisting movement of considerable force when in use. As a result, it is forced to one side, when the carefully tapered hole will no longer match the straight pin; and the bearing is transferred from the calculated line, which reached through the whole thickness of the roll, to a single point. With the rolls out of line, inferior work is produced and the pivot subjected to excessive wear, which shortens the life of the tool.



Rivet Spinning Tool with Improved Bearing for Roll Pivot

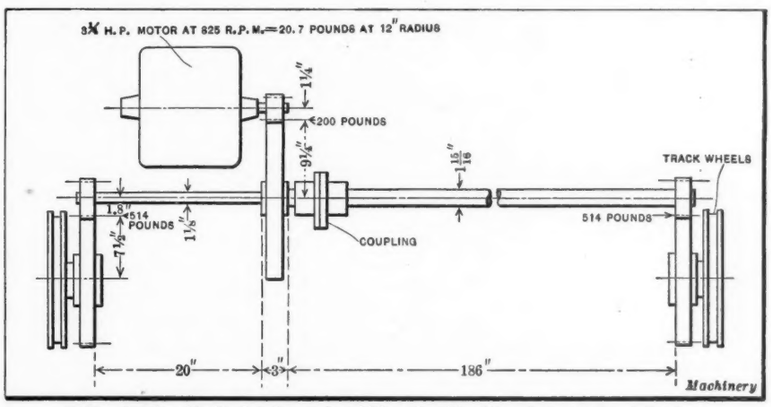
The accompanying illustration shows how these troubles may be avoided by so shaping the pivot that each roll bears upon the circumference of a sphere which, as it fills the hole, allows no side play and thus holds the rolls accurately in line. A brief consideration of the subject will suffice to show that a movement of the pin through the holder and rolls lowers one roll and raises the other, thus allowing them to be matched at their circumference, after which the pin may be fixed in place by the set-screw. This feature of adjustment makes it possible to use a pair of rolls which may vary slightly in diameter, and still match at the working point, thus securing a decided advantage over the old type of holder that is made with a straight pin.

F. W. BARROWS
Bridgeport, Conn.

THE ANGLE OF TORSION

I was much interested in the article of this title by B. D. Pinkney which appeared in the November number of MACHINERY. It will be recalled that this article dealt with the angle of torsion of double or compound geared machines; *i.e.*, it showed the effect of different angles of torsion in a shaft in producing wear in a pair of driving pinions when the power could not be applied directly to the center of the shaft to equalize the torsion. The different angles of torsion resulted in uneven wear on the teeth of the pinions. This condition is very noticeable on the bridge driving shafts of electric cranes, although here it is not so much a matter of uneven wear of the teeth of the driving pinions as the tendency of one end of the crane to travel ahead of the other, or to lag behind as the crane may be. This causes a variety of troubles, such as excessive wear and tear on the crane tracks and wheels, undue wear of the pinion and gear teeth, twisting of the crane bridge, and other equally unsatisfactory operating conditions.

The most obvious method of eliminating the difficulty is to apply the power exactly at the center of the shaft carrying the two pinions, but in many cases this is difficult to accomplish because mounting the motor on a bracket attached to the side of one of the bridge beams near the center of the span means that an excessively large beam must be selected in order that it may possess sufficient lateral strength to support the motor with the required degree of rigidity. This is especially true when the designer is called upon to use beams of standard structural shapes in the construction of the crane bridge. I have in mind the case of a crane which I designed for use in our own shop. This crane was of the three-motor type, *i. e.*, one motor provided to hoist the load, one to drive the hoist trolley on the bridge and one to drive the bridge along the runways. It was the mounting of the last motor referred to that caused most of the trouble. The crane bridge was constructed of two 10-inch 25-pound I-beams which we had in stock. The hoist and trolley occupied all of the space between the beams and traveled on the top of 2-inch rails secured to the top flanges of the beams. As a result, the mounting of the motor at the center of the crane meant that it would have to be supported by a bracket secured to the outside of the web; and as the span was 18 feet and the beam unsupported for its whole length, such construction would have caused too much deflection. I finally placed the motor on one of the end trucks and coupled a shaft to it, which was long enough to deliver the power to the center of the bridge shaft through a gear and pinion.



Bridge Driving Shaft of a Crane, in which a Consideration of the Angle of Torsion would have saved Trouble in designing

Since reading Mr. Pinkney's article I have been wondering whether it would have been practicable to have proportioned the bridge shaft as suggested in the illustration which he designates as Fig. 4. The illustration which accompanies the present article shows the shaft for the crane, to which I have referred, designed in accordance with this idea. Such a method would make it possible to mount the motor on one of the end trucks, where it would be rigidly supported, while the difference in the angles of torsion of the shaft would be taken care of by the difference in shaft diameters, as suggested by Mr. Pinkney. The only question in my mind is whether it would be as satisfactory as to apply the power directly to the center of the bridge shaft. For the conditions under consideration, we see that the torsion moment T is:

$$T = 514 \times 1.8 = 925 \text{ inch-pounds.}$$

The angle of torsion Δ for the 186-inch length of shaft is found from Formula (4) of Mr. Pinkney's article:

$$\Delta = \frac{687.5 \times 925 \times 15.5}{1.36 \times 10{,}500{,}000} = 0.69 \text{ degree.}$$

In the preceding calculation the value of the polar moment of inertia of 1.36 corresponds with the shaft diameter of 1 15/16 inch. Using the same formula and solving for the value of the polar moment of inertia, we have for the 20-inch length of shaft:

$$0.69 = \frac{687.5 \times 925 \times 1.6}{J \times 10{,}500{,}000}.$$

$$J = \frac{687.5 \times 925 \times 1.6}{0.69 \times 10{,}500{,}000} = 0.1405.$$

From the formula $J = 0.098D^4$ we have:

$$D = \sqrt[4]{\frac{0.1405}{0.098}}$$

$D = 1$ 3/32 inch, or say 1⅛ inch which is the required diameter for the smaller shaft.

York, Pa. W. B. GILBERT

A HAND SCREW MACHINE KINK

It sometimes happens that certain kinds of small threaded work produced on automatic screw machines have to be finished on hand screw machines. In such cases the work is usually held by the threaded part and must be screwed onto the arbor before it can be operated upon. Then after the operation is completed the work must be screwed off the arbor. The best kink that the writer knows of for rapidly setting up such work is to mount a piece of fiber in the back toolpost of the hand screw machine. The front end of this fiber block is made to conform to the profile of the work, which is started onto the threaded arbor while the machine is running and screwed up tight against the shoulder of the arbor by bringing the fiber block to bear against the revolving work. As soon as the second operation has been completed, the machine is reversed and the fiber block again brought to bear against the work, causing it to be unscrewed from the arbor and dropped into a receiver placed to catch it. The reason for using a fiber block for this purpose is that it does not injure the finish of the work, and still has the required degree of durability.

TOOL SETTER

WAXING COMPOUND TO MAKE DRAWINGS TRANSPARENT

If it is required to make a blueprint from a drawing on heavy bond paper, trouble is often experienced on account of the amount of time required to make the print, due to the opacity of the paper. If, however, the reverse side of the drawing is rubbed with a compound made by dissolving enough ordinary beeswax in spirits of turpentine to form a thin paste, the paper will become quite transparent and a print may be made from the drawing in a very short time. In applying the compound, a cloth should be used and the compound rubbed well into the pores of the paper. After this has been done, the surplus wax and turpentine should be removed by vigorous rubbing with a dry piece of cloth.

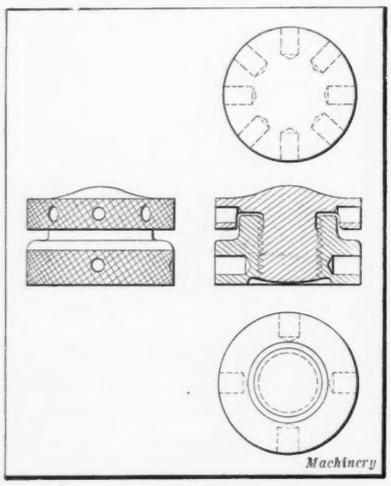
WALTER E. LAMB

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

JACK FOR TRUING UP LATHE WORK

The jack which I am going to describe was designed to meet conditions often found in chucking medium or small sized work, where the time-honored bolt and nut fail to enter a narrow opening where they may be needed for making adjustment. The size of the jack may be made to suit different classes of work, and where economy of space is the first consideration a large "run" of the screw is out of the question. An adjustment of a few thousandths of an inch is generally sufficient, and in the case of the jack shown in the illustration the maximum "run" is only ⅛ inch.

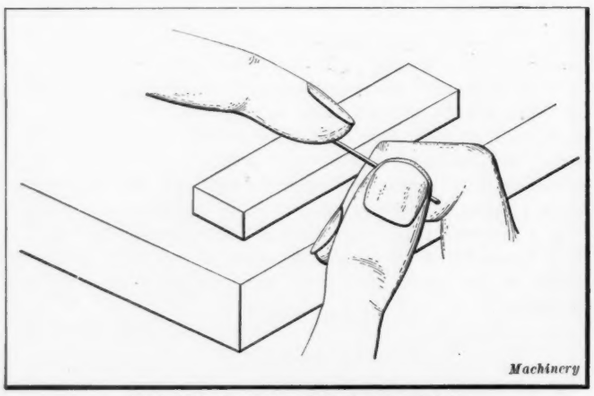


Jack for truing up Work held in Chuck

Turtle Creek, Pa. WILLIAM S. ROWELL

GRINDING DULL COMPASS POINTS

Dull points on a draftsman's compass or dividers are a source of annoyance and inaccuracy, but this trouble can easily be overcome by keeping a carborundum slip for use in occasionally grinding the points to keep them sharp. The accompanying illustration shows the method of procedure which I have found to be very satisfactory. The stone is placed near the edge of the drawing board; and the point to be sharpened is revolved on it by twirling the point between the thumb and index finger of one hand, while the index finger of the other hand is used as a steadyrest.



Method of sharpening Dull Compass Points

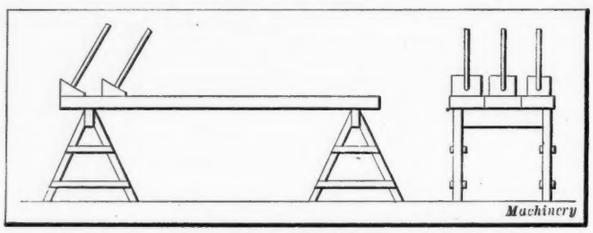
Chattanooga, Tenn. RUSSELL K. ANNIS

TO ENLARGE OR REDUCE DRAWINGS

In the January number of MACHINERY a method was described by Sidney K. Eastwood for enlarging or reducing the size of drawings, which involves laying out a line of given slope on coordinate paper. I can see no reason for some of the steps recommended in this article. Suppose it is required to increase the size in the ratio of 2 to 1; all that is necessary is to lay off a length of 2 inches from a given point on a straight line and from this point draw a perpendicular line 1 inch high. Next draw a line through the starting point and the point thus located, and you have a line of the required slope for increasing the size in the ratio of 2 to 1, or decreasing in the ratio of 1 to 2. For any other increase or reduction, it is merely necessary to have the required ratio between the horizontal and vertical distances which are measured off in constructing the diagram. N. G. NEAR

SHRAPNEL SHELL PAINTING RACK

In making 18-pound English shrapnel shells, the greatest care is required in all departments of manufacture, including the painting of the finished shells. When each shell is ready to be painted, it must weigh 17 pounds, 10 ounces, 14½ drams, and in painting the weight must be increased 5½ drams for the shell to come up to specifications. The accompanying illustration shows a shrapnel shell painting stand which is made from 2- by 4-inch and 2- by 8-inch lumber. The trestle supports the stand at a convenient height from the floor, and the rods which project out from the bevel faces of the blocks enter the central fuse tubes in the shells so that the painter can rotate each shell while he is painting it. The blocks are spaced on the stand so that ample room is provided for painting. The complete stand has a capacity for 120 shells; it should be noted that the illustration shows only a part of the stand.

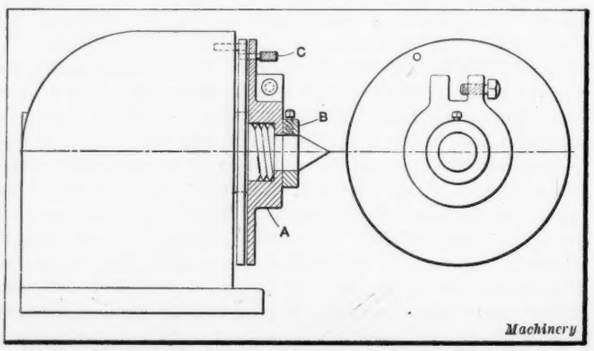


Rack used to support 18-pound English Shrapnel Shells while they are being painted

Hamilton, Ont., Canada. JAMES HAMILTON

A DIVIDING HEAD KINK

The center of a dividing head is likely to become eccentric after long service and this makes it difficult to machine a square arbor concentric with the centers. The following describes an inexpensive device which overcomes this difficulty by making the center dead and revolving the work on it. The accompanying illustration shows a driving plate *A* that takes the place of the driver usually fastened on the center by a set-screw. The driving plate is bored to a running fit on the center and is held in place by a set-collar *B*. The driving plate has an index hole located at the same distance from the center as the holes in the regular index plate. The work is indexed by moving over the desired number of holes and then locking the driving plate by means of the index pin *C*. After the centers have been lined up for milling one side of the work in this way, there is no further trouble with the other three sides.



Driving Plate for Use in overcoming Error in Dividing Head Center

Davenport, Iowa. R. L. ABERNATHY

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NATIONAL BOLT HEADER

In the operation of this machine the gripping of the stock, and the starting and stopping of the machine are performed automatically, so that the operator is merely required to feed the stock into the machine, as in the case of a rivet header. As a result, he does not become unduly fatigued, and there is no falling off of the rate of production or quality of the product from this cause. The machine may be set to make a bolt head in from three to eight blows which are delivered during one cycle; and as the heads of all bolts are finished by the same number of blows, the quality of the finish of the heads of all bolts is quite uniform. These changes of timing are effected by a simple gear and cam mechanism. There is no clutch on the main shaft; the heading slide, hammer levers, and main shaft run continuously.

A recent addition to the line of bolt and nut machinery manufactured by the National Machinery Co., Tiffin, Ohio, consists of a continuous-motion semi-automatic hammer type of bolt header which is adapted for forging the heads of square, hexagon, and T-head bolts from heated stock. The design of this machine has been worked out in such a way that the gripping of the stock, and starting and stopping of the machine are performed automatically, so that the operator does not have to do this part of the work and can devote his entire energy to feeding the machine. The main shaft, heading slide, and hammer slides of the machine run continuously, and as a result the machine tends to set the pace for the operator. Relieving the operator of the work of manipulating the levers for the purpose of gripping the stock, and starting and stopping the machine, does away with excessive fatigue, so that there is no falling off of the rate of production or quality of the work from this cause. The elimina- of the starting and stopping clutch on the main shaft, which is secured through having the main shaft, heading slide, and hammer slides run continuously, does away with troubles resulting from wear or breakage of the clutch members, and enables the machine to run at higher speeds.

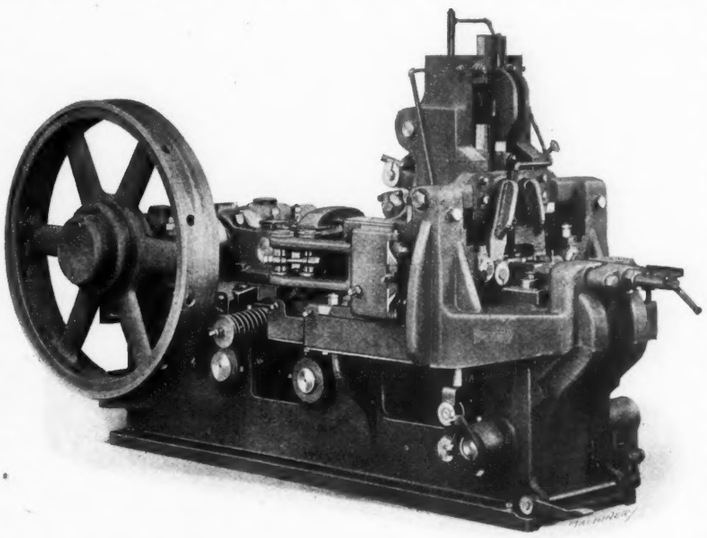


Fig. 1. The National Continuous-motion Semi-automatic Bolt Header

An important feature of the design of this bolt header consists of the provision of a simple gear and cam mechanism which enables the machine to be set or timed in such a way that the heading operation is completed by from three to eight blows which are delivered during a single cycle. With the machine set to deliver a predetermined number of blows in this way, the finish of the heads of the bolts is necessarily uniform. The time that the grips are open for feeding the stock can also be regulated to suit the length or type of bolt which is to be made. The bed of the machine is of box construction, and it is heavily ribbed to provide a high degree of strength and rigidity.

All parts of the mechanism are made correspondingly massive. As a result, the heading can be performed in this machine in the minimum of time, and with a minimum number of blows, so that the best possible conditions are obtained for the flow of the metal to enable it to fill out the corners of the head. This also makes it possible to work the metal at the lowest temperature that is practical, which is the means of affording a better finish.

The importance of great rigidity in this machine, and the provision which has been made for completing the heading operation with the minimum number of blows, makes it necessary for the machine to be exceptionally heavy. For example, the 1-inch machine weighs approximately 13,000 pounds; but this unusually heavy construction has not caused the speed to be lowered. The 1-inch machine just referred to runs at 140 revolutions per minute on work of the maximum size for which it is adapted, and this speed can be materially increased when running on smaller sizes of work. The rigid constructon of the machine, combined with the feature of a mechanically operated gripping device, has made it possible to introduce a cut-off attachment in the gripping dies, so that short bolts can be made direct from the rod. The provision of this attachment enables short bolts to be made just as efficiently as the longer ones. Four to six bolts can be made from one heat, the number depending somewhat upon the diameter and length of the bolts which are being produced.

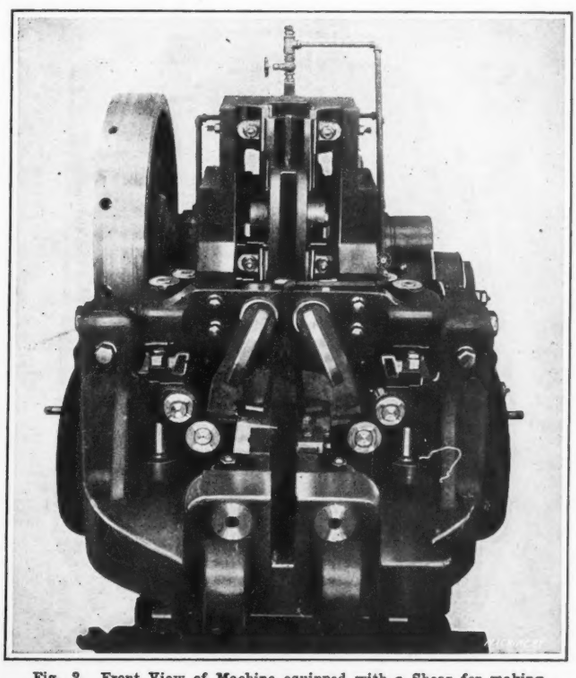


Fig. 2. Front View of Machine equipped with a Shear for making Bolts off the Rod

Another feature consists of a yoke lever substituted in place of a slide for carrying the lower hammer. The claim is made for this construction that it takes the bearings out of the zone of scale and water, and thus avoids the excessive wear and disalignment which would otherwise result from damage done in this way. It is claimed that this feature of the design will prove an important factor in reducing the cost of upkeep on the machine.

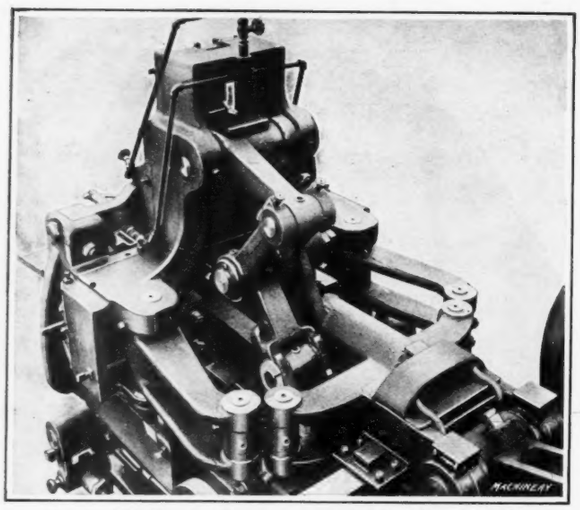


Fig. 3. The Hammer Levers are operated by Links to avoid Excessive Wear and Lost Motion

The slides which carry the side and top hammers are operated by bronze-bushed links, a construction which is claimed to be particularly satisfactory in that it eliminates excessive wear, spring, and lost motion. The flywheel is of the friction-slip construction which has been adopted on headers and forging machines built by the National Machinery Co., and serves as an automatic safety device in case cold stock or an excessive amount of metal is fed into the machine and ob-

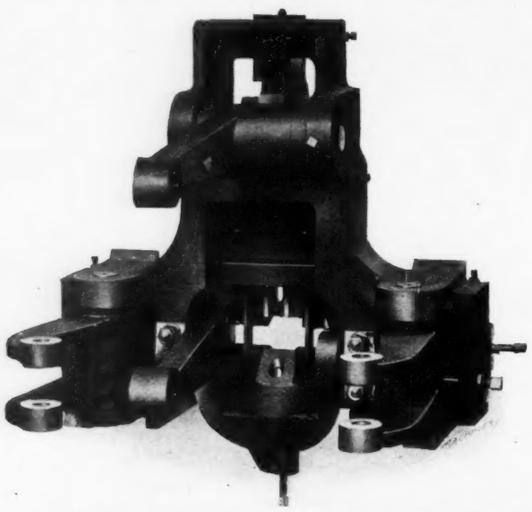


Fig. 4. The Lower Hammer Yoke-lever Construction that avoids Damage done to a Slide by Scale and Water

structs the travel of the heading tool. This flywheel also serves to protect the motor from damage in cases where direct motor drive is employed. An automatic relief device is also provided on the gripping mechanism to protect the machine from damage, should the operator accidently get stock or some foreign object between the grips in such a way that it would prevent them from closing, and consequently prevent the machine from completing its regular cycle.

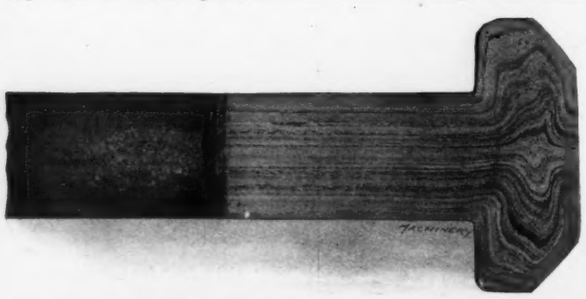


Fig. 5. Etched Section of an Iron Bolt Head made on the Machine, showing how the Metal Fibers are left unbroken after the Upsetting Operation so that the Bolt has the Maximum Strength

The slides in this machine have been made exceptionally long, and the shaft bearings are of large diameter; all shaft bearings are bronze-bushed, and the main shaft bearings are automatically lubricated. All bearings have large oil pockets or cup oilers that are readily accessible and these

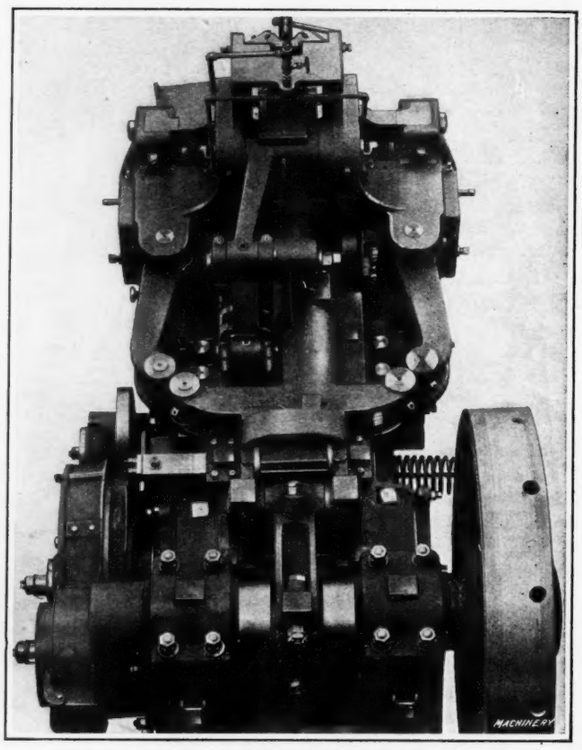


Fig. 6. Rear View of the Machine showing Liberal Dimensions of all Parts of the Mechanism

pockets, in common with all oil holes, are provided with sliding or hinged covers which guard against the possibility of scale or other foreign matter finding its way into the bearings. From the preceding, it will be evident that the design has been carefully worked out with the view of providing means to overcome all avoidable bearing troubles. The National Machinery Co. is building this continuous-motion semi-automatic hammer type of bolt header in three sizes which have capacities for heading stock up to ¾ inch, 1 inch,

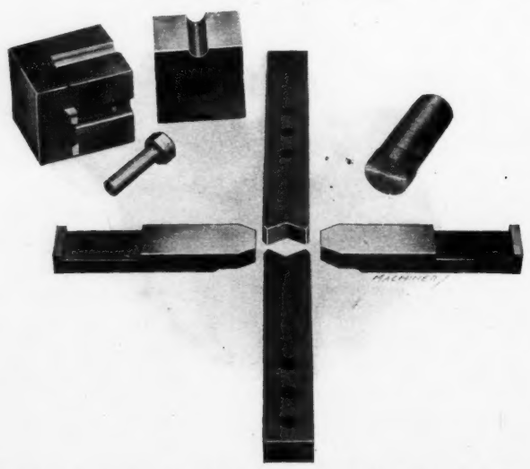


Fig. 7. A Set of Dies for Use in making Hexagon Bolts off the Rod; the Shear is attached to the Left-hand Gripping Die

and 1½ inch in diameter, respectively. The machines can be equipped for either belt drive or individual motor drive, according to the requirements of the shop in which they are to be used.

TAFT-PEIRCE TOOL-ROOM SPECIALTIES

In introducing this line of tool-room specialties, the purpose is to provide tools which are made on a manufacturing basis, where advantage can be taken of every possible economy in production. As noted in the article, the different sizes in which these tools are made are carried in stock, so that prompt deliveries are assured. Each of the tools has been carefully tried out under actual working conditions in the tool-room of the Taft-Peirce Mfg. Co., and during the course of these tests, all weak features of the design have been detected, and remedies applied.

The result of a wide experience in tool making led the Taft-Peirce Mfg. Co., Woonsocket, R. I., to believe that many manufacturers would be glad to avail themselves of the opportunity of purchasing such tool-room specialties as parallels, V-blocks, sine-bars, etc., if they could be obtained in suitable sizes, instead of having such work done in their own tool-rooms. As a result, the line of tools which forms the subject of this article has been designed and thoroughly tested out in the factory of the Taft-Peirce Mfg. Co. before being offered to the public. The claim is made that by having these tools carried in stock, as in the case of other machinists' small tools, the purchaser secures the double advantage of securing tools at a lower price, which are fully as good as his own toolmakers could produce; and of avoiding loss of time which occurs when orders have accumulated in the tool-room, so that each must await its turn before receiving attention.

Fig. 1. Double-end Internal Limit Gage

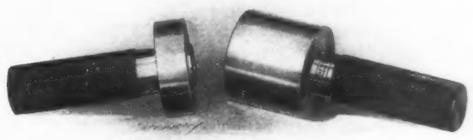


Fig. 2. Single-end Internal Limit Gages

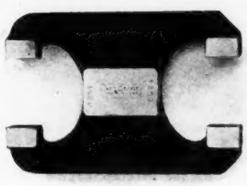


Fig. 3. External Limit Gage

Fig. 4. Single-end External Gage

Fig. 5. Adjustable Limit Gage

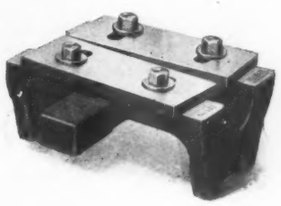


Fig. 6. Adjustable Taper Gage

Internal and External Gages

In designing the line of internal and external limit gages, no attempt has been made to bring out a line of standard plug- and snap-gages as it is believed that this demand has already been met in a very satisfactory manner by other manufacturers. The main object was to standardize the sizes and styles of the gage members so that a customer can order any number of gage-plugs or handles from stock at any time, and be sure they will interchange with the gages he already has in use; moreover, he can secure them without delay. Fig. 1 shows the internal-limit or plug-gage of the double-end type, with the "go" plug at one end and the "not-go" plug on the opposite end. The gage may be readily taken apart, as shown in this illustration, and different gage-ends substituted by simply loosening the screws in the ends. The flexibility of this type of gage is further increased by having the plugs so well fitted that they may be easily reversed on the handles, thus practically doubling their life.

All sizes of these gages are carried in stock from ½ inch to 3 inches by steps of 1/16 inch. Special attention is called to the fact that for each standard size there are three variations obtainable in "go" plugs, and three variations in "not-go" plugs, all of which can be supplied from stock. There are "go" plugs of standard size, also 0.0005 inch undersize and 0.001 inch undersize; and there are "not-go" plugs of standard size, 0.0005 inch oversize and 0.001 inch oversize. All of these plugs fit the same handle, and four standard sizes of handles are used to cover the range of gages from ½ inch to 3 inches. From this it will be seen that stock limit gages or stock plugs may be obtained at any time for work of a given size, and the choice of limit plugs will fit in with the shop system working to 0.001 limits or to 0.0005 limits, above standard, below standard or both sides of standard. The economical feature of being able to make up different combinations of limits from one set of gages will be readily appreciated. Fig. 2 shows a single-end type of internal gage made up by using a different type of handle with the same plugs that are employed on the double-end gage shown in Fig. 1. The "not-go" gage is shown on the left- and the "go" gage on the right-hand side of the illustration. The plugs are held from turning on the handles by means of small keys.

Fig. 7. Sine-Bar

The features of the external limit gage illustrated in Fig. 3 are the

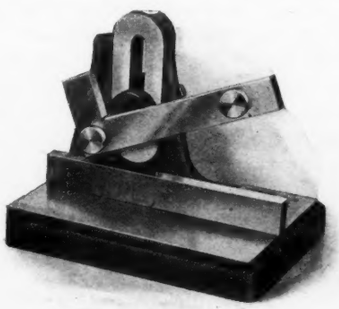


Fig. 8. Sine-Bar Fixture

Fig. 9. "Measuring-iron"

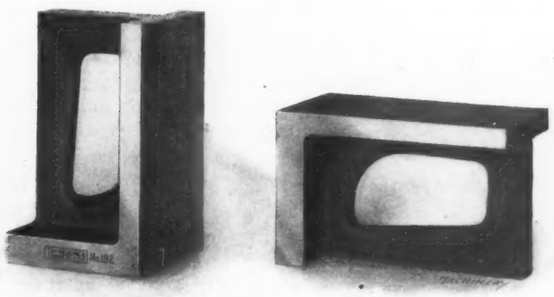


Fig. 10. Universal Right-angle Irons

provision of exceptionally large gaging faces, and a thin web of the drop-forging that ties the four extremities of the gage together to prevent springing or injury of the tool when placed in the hands of a "hustling" pieceworker. This type of limit gage has thus far only been made for gaging rough-turned work. Sizes from ¼ inch to 2 inches, varying by steps of 1/16 inch are carried in stock. The tolerance provided on these gages under the 1-inch size is about 0.008 inch; and from the 1- to 2-inch sizes, it is about 0.012 inch. Single-end gages of the form shown in Fig. 4 are also carried in stock in sizes from 2 to 3 inches, with a tolerance of 0.015 inch. Large pads carry the size inscriptions on both types of gages.

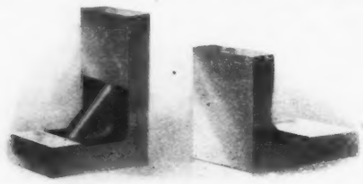


Fig. 11. Toolmaker's Knees used for setting up Work

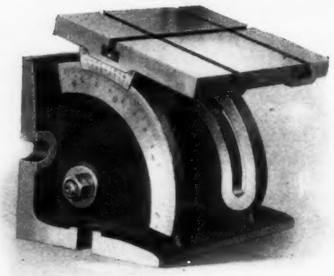


Fig. 12. Knee provided with Means of Angular Adjustment

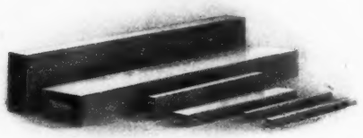


Fig. 13. An assortment of the Steel Parallels

Another type of external limit gage is shown in Fig. 5, which has the lower gaging face fixed, and two opposite "go" and "not-go" points independently adjustable. These adjustable gaging points are threaded into sockets and they may be clamped in any desired positions. The ends are made slightly convex to afford a better contact with the surface that is being gaged. Thirteen stock sizes of this gage cover all diameters from ¾ inch to 7 inches. One of the advantages of the large flat lower gaging face is that the work cannot drop down between the two gaging points.

Included in this line of gages is a taper gage illustrated in Fig. 6, which consists of two adjustable hardened and ground straight edges mounted on a cast-iron body. There is a convenient handle on one side with which the gage may be held while in use or, if preferred, it may be clamped in a vise.

Fig. 17. Bench Plate

The gage may be quickly set for any taper. Three sizes of this gage are provided, the smallest having blades 3 inches long and taking diameters up to 1 inch at the large end of the taper; the medium size having blades 5 inches long and taking work up to 1⅝ inch in diameter at the large end; and the largest size having blades 7½ inches long and taking diameters up to 2⅞ inches at the large end.

Sine-Bars and Sine-Bar Fixtures

It is believed that Figs. 7 and 8 show the first sine-bar and sine-bar fixture that has ever been manufactured for the market. These tools are intended for laying out or testing any work where angles are involved, according to the usual method. The studs are exactly 5 inches apart on the bar, so that by finding the difference in height of the two studs, when set on the work, and dividing this difference by 5, the result will be the sine of the angle which is to be laid out on the work. The bars are made of steel, hardened and ground so that the edges are parallel with a line passing through the center-line of the studs.

In the case of the sine-bar fixture shown in Fig. 8, the bar pivots on a stud that has a vertical adjustment to accommodate work of various thicknesses or diameters. A projecting edge of the upright and one end of the base are finished, so that the fixture will stand square when this end is placed on a flat surface. In this position the sine-bar can be set to angles of nearly 90 degrees with the base, by using the sine of the complement of the angle. This is a more accurate method owing to the greater difference in the sine of the complement of the angle per degree, as the angle approaches 90 degrees.

Angle-Irons and Knees

The "measuring-iron" shown in Fig. 9, is primarily intended for use on the milling or boring machine, to provide a surface from which accurate measurements may be taken in locating the work. It also may be used for laying out or locating work on other machines or on a bench plate. These angle-irons are made of fine-grained cast iron and are accurately finished by planing. They are made in two sizes, the smaller being 2½ inches wide, with angle faces measuring 6 by 8 inches; while the larger size is 4½ inches wide and the angle faces measure 12 by 20 inches. Similar to the measuring-irons, but more adaptable in their use, are the universal right-angle irons shown in Fig. 10. A web is cast in the center of the back of these irons; and as they are finished all over, they may be used in either of six positions. Work may be clamped to either of the two main faces and the angle-iron set in different positions without the necessity of relocating. These angle-irons are intended to be used in the pattern shop as well as in the tool-room. Four sizes are furnished varying from 3¾ to 8 inches in width, with angle faces ranging from 4 by 5 inches up to 16 by 20 inches in length.

The toolmaker's knees illustrated in Fig. 11 are used in a variety of ways in setting up work, where accuracy is absolutely necessary. They will also be found most useful by the inspector in checking up work. Still another important use is for holding small parts on the surface grinder for light

Fig. 14. Cast-iron Box Section Parallels

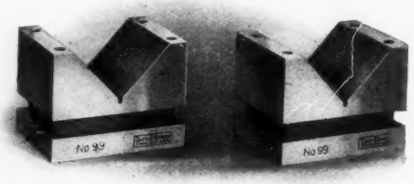


Fig. 15. V-Blocks

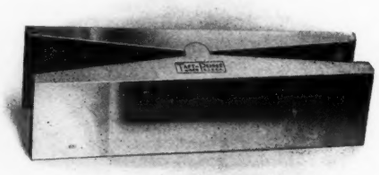


Fig. 16. Equalizing Jaws for holding Tapered Work

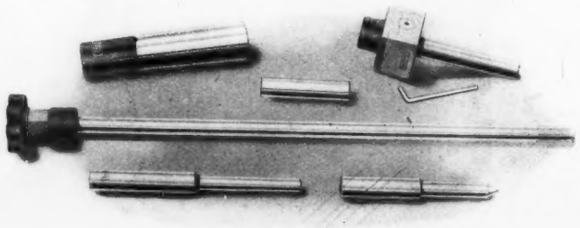


Fig. 18. Boring Equipment for the Milling Machine

grinding operations. The width of these knees is 2½ inches and the length of the angle faces is 3 and 4 inches. A more elaborate tool of this kind is the adjustable knee shown in Fig. 12. On the table of this knee, work may be located and any desired angle of inclination quickly obtained. The setting for the angle is obtained from a vernier, which provides for making settings within 5 minutes of accurate. If desired, this fixture can also be equipped for setting to the sine of any angle. The working face is 7 by 10 inches in size, and T-slots are provided for clamping the work. The extreme height of the table when horizontal is 9 inches.

Parallels, V-Blocks, Equalizing-Jaws and Bench-Plate

One of the most important members of the line of tool-room specialties which is now being carried in stock by the Taft-Peirce Co. is a series of different sizes of parallels, an assortment of which is shown in Fig. 13. These are made of a special grade of steel, and they are hardened and ground on four sides, with the edges slightly rounded to avoid burring. Thirty-four sizes are carried in stock. The sizes range from 5/16 by ¼ by 5 inches up to 1½ by 1¼ by 8 inches. The sizes are interchangeable in every way. Another type of parallel included in this line are the box parallels shown in Fig. 14, which are intended to supplant the use of steel parallels when mounting work for inspection or when the use of smaller parallels would require too much building up. These are made of cast iron, cored out as shown to reduce weight, and are ground on all six faces. The cored holes also provide means for clamping. Three sizes of these tools are made, namely, 4 by 4 by 6 inches, 4 by 6 by 6 inches, and 5 by 8 by 12 inches, respectively.

The V-blocks shown in Fig. 15 are made of steel, and they are hardened and ground all over. Particular attention has been paid to grinding the vees so that they will be central with the outside edges of the blocks to insure perfect alignment. Wide grooves are cut around the blocks to provide means for clamping; and for convenience in attaching gages or other parts, holes have been drilled and tapped in the top faces. These blocks measure 2⅞ by 2⅞ by 4 inches, and the clearance groove at the bottom is ⅛ inch wide.

Another of the tools in this line is the pair of equalizing jaws shown in Fig. 16, which are intended for use in the machine vise to hold tapered or other unequally sized work. The jaws are made of hardened tool steel with the faces and sides of the jaws accurately ground. A cylindrical fulcrum in the center of the back of one of the jaws fits into a corresponding recess in the back of the other jaw, and thus allows the faces of the jaws to adjust themselves to the work. Both the cylindrical rib and recess are form-ground so that they fit perfectly. These jaws are 5⅛ inches long, 1¼ inch high, and 1½ inch wide, when the faces are parallel.

The bench-plate illustrated in Fig. 17 is made for general bench use and is not intended to be used as a surface plate. These plates are made of fine-grained cast iron; they are well reinforced, and thick enough so they may be refinished a number of times. The surface is finished either by scraping or planing. The edges are machined square with each other and with the surface of the plate. The dimensions are 13 by 15 by 3 inches thick, and the weight is about 55 pounds.

Boring Equipment for Milling Machines

Fig. 18 shows a special equipment to be used on the milling machine for performing accurate boring operations on jig, fixture and similar work. It consists of a draw-in rod, a collet, three reducing sleeves, a test plug, a work center, and a boring tool-holder. The outfit is standard for milling machines having a No. 10 or No. 11 Brown & Sharpe taper hole in the spindle. The draw-in rod is furnished to fit any length of spindle, one end being threaded to fit the collect and the other end provided with a knob for tightening. Below the knob, the casting is hexed off to permit the use of a wrench for tightening. The collet is made of tool-steel, which is hardened and tempered; and the reducing sleeves permit tools with shanks ⅜ inch, ½ inch, or ⅝ inch in size to be used. These sleeves are hardened, tempered and ground to size.

The test-plug is found helpful in locating work accurately with relation to the spindle. It is 1½ inch in diameter at the plug-end and the shank that fits the collect measures 13/16 inch in diameter. The over-all length of the test-plug is 8 inches. The function of the work-center is to aid in locating center holes, centering taps and reamers. etc. The fact that it is held in a straight collet means that it can be adjusted lengthwise, a feature that is not available with solid taper-shank tools. The center is hardened and ground. Its over-all length is 6 inches. The special boring tool of this equipment has an adjustable cross-slide operated by a fine-threaded screw which is carefully graduated so that readings may be taken to determine the relative movement of the tool. The clamping and adjusting screws do not project above the surface and both are controlled with a single wrench. A special straight shank drill chuck, and special drills and reamers, as shown in Figs. 19 and 20, respectively, are provided for use with the outfit.

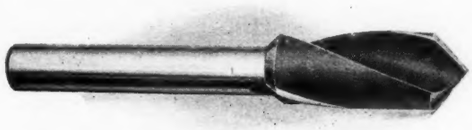


Fig. 19. Drill for use in Equipment shown in Fig. 18

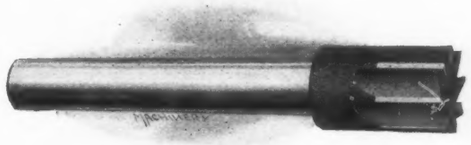


Fig. 20. Reamer for use in Equipment shown in Fig. 18

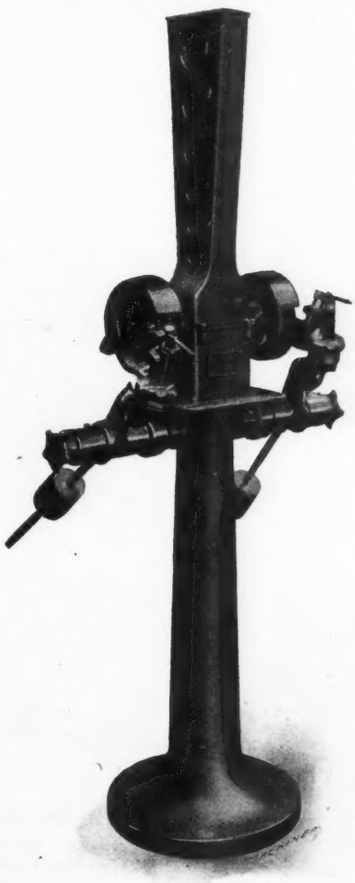


Fig. 1. Gleason Grinder for sharpening Cutters for Two-tool Bevel Gear Generators

GLEASON TOOL GRINDER

For use in sharpening the tools used in the two-tool type of bevel gear generating machines of their manufacture, the Gleason Works, Rochester, N. Y., have recently placed upon the market a tool grinder which is illustrated and described herewith. This is a single-purpose machine in that it is only intended for sharpening one type of tool; and the decision to manufacture this machine for sale to users of Gleason two-tool bevel gear generating machines resulted from the very satisfactory service obtained from machines of this type which have been in use at the Gleason Works for several years.

It will be seen from the illustration that there is a wheel at each end of the spindle. Under each wheel there is an adjustable swinging arm which carries a universal tool-holder; the upper tools are ground by one wheel and the lower tools by the other. The wheels run in the direction indicated by the arrow in Fig. 2, and the holders are

so arranged that the grinding is always against the cutting edge of the tool, thereby eliminating the burring of the edge. Each tool-holder has a turning movement on its binding stud which is controlled by a positive stop in both directions, these stops being set for a 14½-degree tool in one direction and a 20-degree tool in the opposite direction. Lines on the side of the tool-holder indicate which way it should be set, and the swivel joint is graduated both ways to facilitate setting for any special pressure or rake angle.

The machine is of very simple construction and convenient to operate. Its use insures accuracy of the tools because they are all ground with a cutting edge exactly square with the cut, which eliminates the necessity of grinding to a gage. This not only saves time but it also eliminates the tendency to grind away more stock than necessary in sharpening cutters. As a result, the life of the tools is prolonged. The

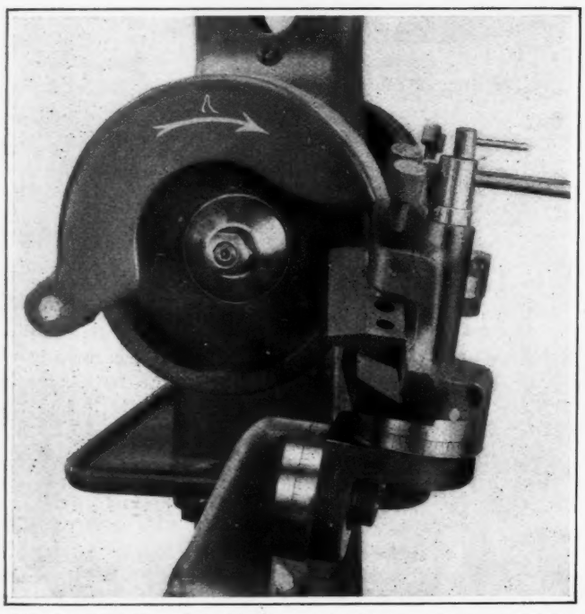


Fig. 2. Close View of the Universal Tool-holder on the Gleason Grinder

wheel spindle is made of hardened steel and accurately ground to size; it runs in bronze bearings which are provided with means of compensation for wear. The equipment furnished with the machine includes a countershaft and two 7 by 2 by ⅝ inch cup wheels. The floor space occupied by the machine is 18 by 31 inches, and the net weight 300 pounds.

GARVIN SQUARE-HEX MILLING ATTACHMENT

Fig. 1 shows a four-spindle, vertical square-hex milling machine attachment which is intended for use in performing such operations as hexing spark-plug nuts, squaring screw or bolt heads, straddle milling, and a variety of similar classes of work; and Fig. 2 shows the attachment in use on a Garvin milling machine. The attachment can be arranged for holding the work by double taper contraction collets operated by

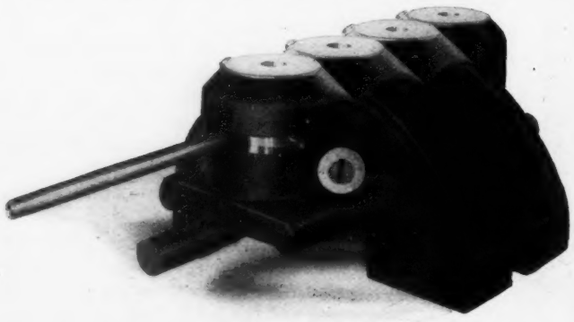


Fig. 1. Garvin Square-Hex Milling Attachment

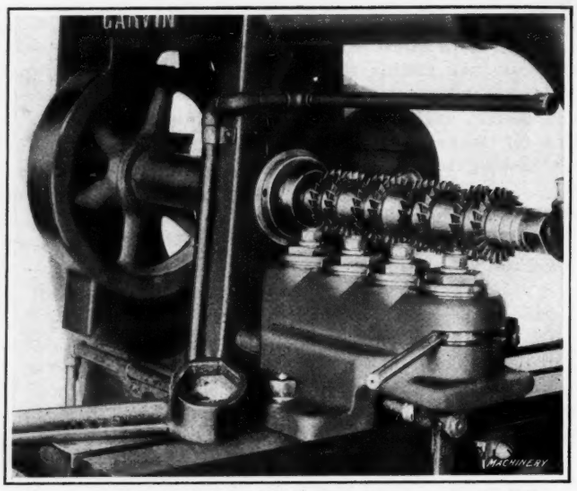


Fig. 2. Square-Hex Milling Attachment in Use on a Garvin Miller

a wrench, which is shown on the milling machine table in Fig. 2; or the work may be held on the threaded arbors or plugs, and when this method is employed the fixture is of the form shown in Fig. 1. The work is run up tight against the hardened steel washers or collars by using a special wrench which is also employed for taking off the finished work without marring its surface.

The four spindles of the attachment are geared together so that a single operation provides for indexing all of the spindles for either hexing or squaring operations. The indexing lever is the horizontal lever shown in Figs. 1 and 2; and the vertical lever shown below the attachment in Fig. 2 is arranged to eject the finished work after the collets have been released. The collets have a capacity of 1½ inch, and the distance between centers of the spindles is 3 inches. This attachment is one of the latest products of the Garvin Machine Co., Spring & Varick Sts., New York City.

PEERLESS DRILL AND REAMER HOLDER

To provide for obtaining perfectly true holes when drilling and reaming operations are performed on a lathe, the Peerless Machinery Co., 44 Binford St., Boston, Mass., has placed upon the market a floating drill and reamer holder which is illustrated and described herewith. The capacity is from ¼ to 1¼ inch and the floating feature effectually prevents the production of bell-mouthed or tapered holes which

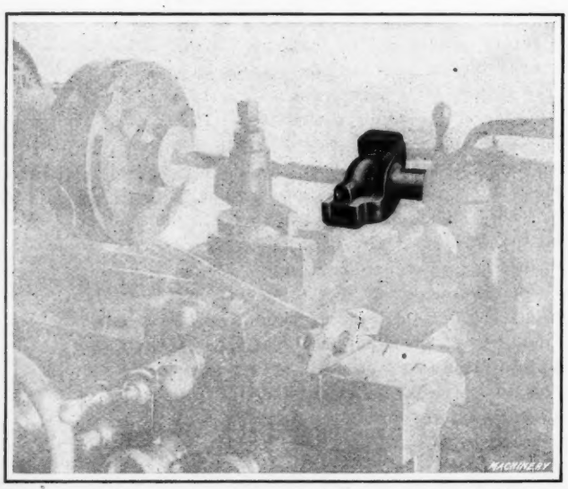


Fig. 1. Tool-holder as it is employed for Drilling and Reaming Operations

are likely to result if the drill or reamer is rigidly held in the tailstock spindle. Another feature is that the danger of breaking the tool at the time when it cuts through the work is eliminated; and this does away with the liability of the mechanic having his hands cut or fingers broken, a form of

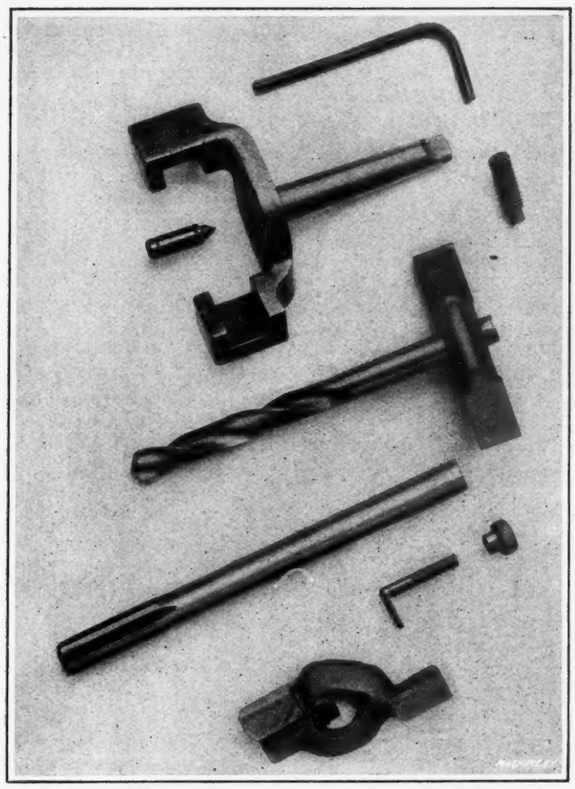


Fig. 2. Parts of the Peerless Drill and Reamer Holder

accident which sometimes occurs when a drill which is held by an ordinary dog slips off the center. The avoidance of this danger was the direct cause which led to the development of this tool-holder. With chucking work, it is not necessary to use a centering tool to start the hole, as the facing tool in the tool-post held against the suspended end of the drill provides for obtaining a perfectly true center.

This tool may also be employed in steady-rest work, for facing, internal screw cutting and boring; and drilling and tapping operations may readily be performed by using the tool-holder in the headstock instead of in the tailstock, as in the case of chucking operations. Fig. 1 shows the tool-holder as it is employed for drilling and reaming operations, and Fig. 2 shows the parts of the holder. Referring to the latter

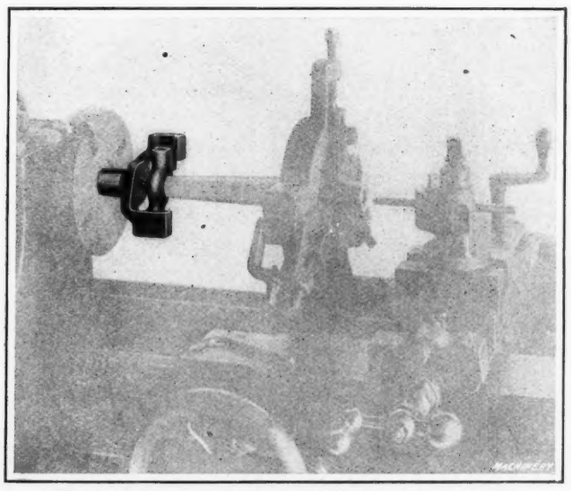
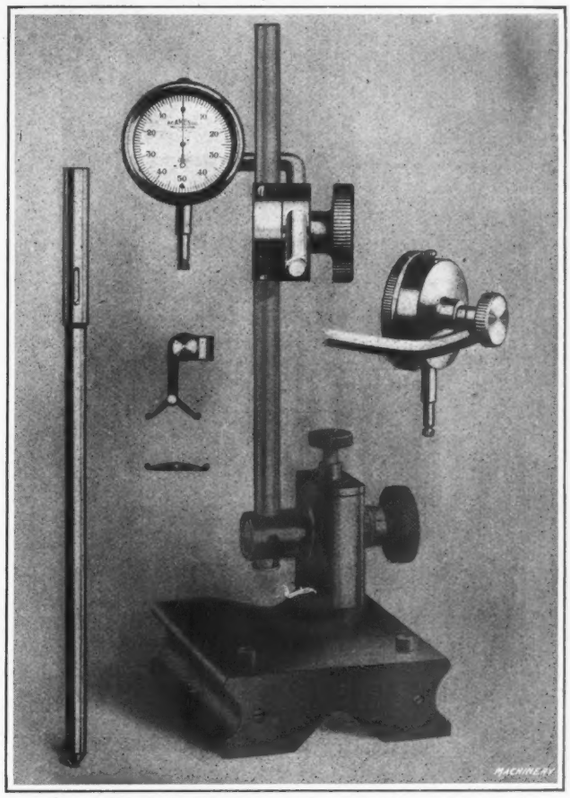


Fig. 3. Holder mounted in the Lathe Headstock to provide Reverse Motion for Tapping

illustration, the way in which the drill or reamer is supported on the center in the holder, and still prevented from slipping forward by means of the dog which has drivers fitting into the grooves in the holder, will be readily understood. Fig. 3 shows the holder carried in the headstock of the lathe, as it is employed for the performance of drilling and tapping operations on parts carried in a steadyrest.

AMES TEST GAGE

The accompanying illustration shows what is styled a No. 22 toolmaker's test gage which has recently been placed upon the market by the B. C. Ames Co., Waltham, Mass. As shown in the illustration, this gage is intended for use in connection with the stand of a surface gage, and this stand is not included as part of the test gage equipment. However, most toolmakers have a surface gage in their kit so that a stand is available for this purpose. The gage is fitted with an Ames No. 5 gage head which is guaranteed to be accurate to 0.0005 inch in the entire run of the gage. When used on a surface plate, this gage makes a very useful tool for laying out jigs and fixtures, testing duplicate pieces of work for thickness, etc. Although primarily intended for the use of toolmakers, the gage is suitable for use in a great variety of metal working establishments. For instance, it can be em-



Ames Toolmaker's Test Gage mounted on a Surface Gage Stand

ployed for testing the bearings, spindles, slides, centers and other parts of machine tools; and planer and surface grinder work can be tested for thickness without removing it from the platen.

CLEVELAND TOGGLE DRAWING PRESS

The Cleveland Machine & Mfg. Co., 4944 Hamilton Ave., Cleveland, Ohio, has recently added to its line of power presses, a toggle drawing press which is illustrated and described herewith. The most important feature of this machine consists of the provision of a mechanical movement for operating the blank holder slide. This movement gives a complete dwell to the blank holder during more than 90 degrees of travel of the crankshaft, and is timed to release the blank shortly after the crank passes the lower center, and rises at practically the same speed as the plunger, thus giving the maximum amount of time for the removal of the stamping and the substitution of a fresh blank in the die. One of these new toggle presses is illustrated in Fig. 1, and Fig. 2 shows a chart giving the relative travel of the plunger and

blank-holder slide on both the down and up strokes, and the dwell of the blank-holder during the drawing operation.

The blank-holder and its supports are designed to resist a strain equal to that exerted by the plunger during the drawing operation without any tendency to spring, and this extreme rigidity of the holding parts, together with the complete dwell of the blank, permit drawing operations to be conducted up to the full capacity of the press with a very small percentage of broken or defective work. Reference to Fig. 1 will show that the tie-rod form of construction has been adopted, in which the bed, arch, and housings are tied together by steel rods which are shrunk into position under a greater strain than the maximum overload capacity of the press. Tongue and groove joints are provided between the housings and bed, and between the housings and arch, to preserve perfect alignment under all operating conditions. The yokes, rocker-shafts, cranks, links, and connections operating the blank-holder slide are steel castings, and all pin bearings are bronze-bushed. All of the gears and pinions are of steel, with the teeth cut from the solid metal; and the crankshaft is made of high carbon open-hearth steel which is carefully heat-treated.

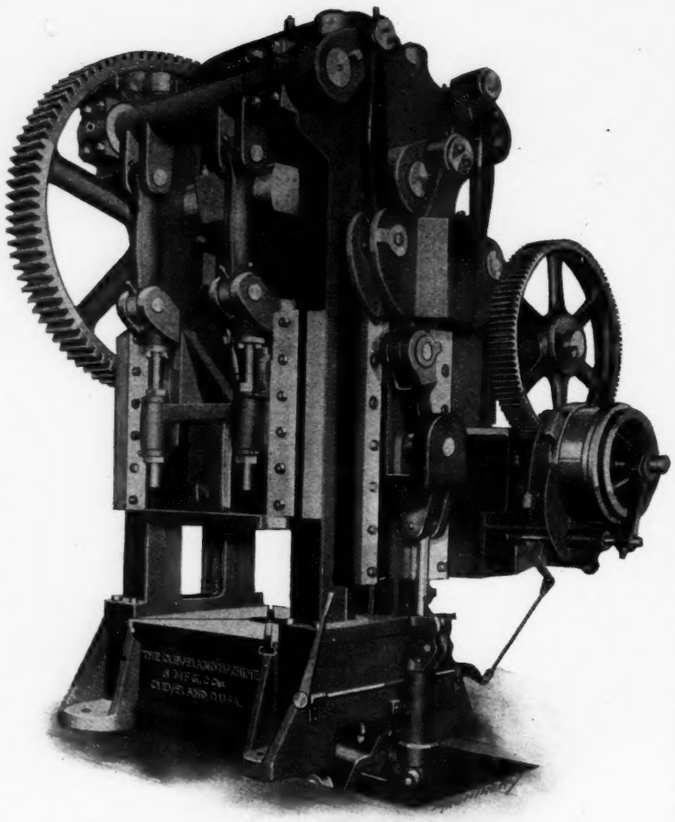


Fig. 1. The Cleveland No. 111 Toggle Drawing Press

The bottom knock-out is operated from the outer slide and provided with an adjustable trip to release the plunger when the stamping is lifted to the top of the die, so that the knock-out plate will drop to the bottom of the die where it will not interfere with the setting of a fresh blank in position. The plunger acts in an air chamber which cushions the return stroke. The friction clutch is of the multiple disk type and has universal adjustment of the friction disks. The brake arms and clutch disks are locked by toggle links which are operated by a hand lever. The friction brake ring is separated from the clutch drum, and it is said to be practically impossible for the clutch to become heated while in operation. The perfect balance of this clutch makes it unnecessary to employ an outboard bearing at the end of the shaft.

The machine shown in Fig. 1 is the No. 111 Cleveland toggle drawing press, and the dimensions of this machine are as follows: drawing capacity, 12½ inches; bed area, 52 by 52 inches; blank holder area, 52 inches wide by 48 inches long; plunger area, 40 inches wide by 35 inches long; stroke of plunger, 26 inches; stroke of blank-holder, 18 inches; distance from bed to blank-holder at the bottom of the stroke and with the adjustment up, 28 inches; distance from the bed to the plunger at the bottom of the stroke and with the adjustment up, 30 inches; adjustment of blank-holder and plunger, 8 inches; speed, 7 strokes per minute; and weight, 110,000 pounds. These machines are built in fifteen other sizes, so that a complete line of these toggle drawing presses is available to meet the requirements of the work for which they are adapted.

* * *

ECK DIRECT-CURRENT MOTOR

In designing the Type D direct-current motor which is a recent product of the Eck Dynamo & Motor Co., Belleville, N. J., the features of commutating poles, positive ventilation by means of internal fans, and the employment of self-aligning ball bearings have been included. Commutating poles have greatly improved the operation of direct-current motors in that they neutralize the harmful effect of the armature field and create a force in the armature coils directly under them. This insures complete reversal of the current in these coils while the commutator bars, to which they are connected, are under the brushes. Sparkless commutation, and long life of the commutators and brushes is thus assured.

The fans giving positive ventilation were adopted to re-

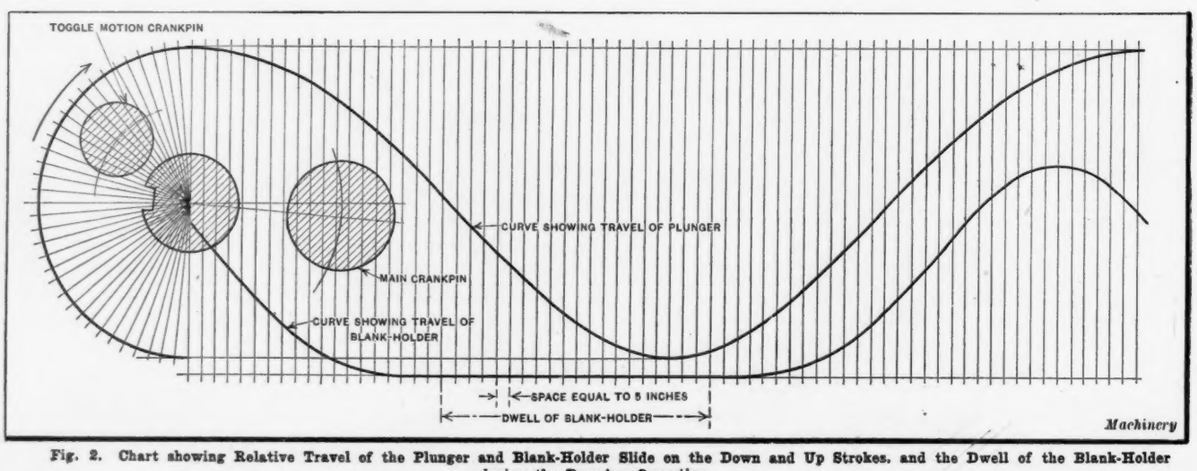


Fig. 2. Chart showing Relative Travel of the Plunger and Blank-Holder Slide on the Down and Up Strokes, and the Dwell of the Blank-Holder during the Drawing Operation

duce the temperature rise, unavoidable in the operation of electric motors. This rise of temperature is due to resistance offered by the windings to the passage of the current, the losses in the iron under magnetic influence, the friction of the brushes on the cummutator, and friction of the shaft bearings. Excessive heat results in injury to the insulation and increased copper losses. To avoid these troubles, air channels lead to the interior of the armature, and through the commutator and core in directions both parallel and at right angles to the shaft. The fan drives cool air through these channels and prevents excessive heating. The use of self-aligning double-row ball bearings provides highest transmission efficiency of the bearings, together with greater durability and ease of maintenance.

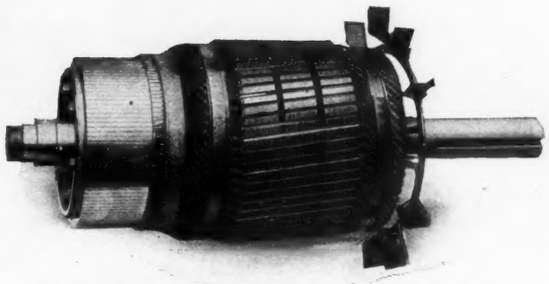


Fig. 1. The Complete Armature showing Ducts in the Core to permit the Passage of Air from the Center to the Periphery

Fig. 2. End View of the Armature and Commutator

Having referred in general to the features of the Eck Type-D motor, brief mention will now be made of certain specific features of the machine. The field frames are made of soft cast steel of high magnetic permeability and afford full protection for the windings. The main poles are made of laminated sheet steel, the laminations being assembled under pressure and riveted together. Ventilating spaces are provided in the poles through which a current of cool air is delivered by the fan, so that both the interior and exterior of the field coils is kept cool. The commutating poles are made of machine steel, and they are fastened to the field frame in the same manner as the main poles. The main field coils are wound on spools made of sheet metal and horn fiber. Ample insulation is provided between the spools and the windings, and the coils are dipped in a moisture-proof insulating varnish, after which they are thoroughly baked.

The armature is carried by a machine steel shaft of liberal size, and through the use of ball bearings the length of the shaft has been reduced so that it has an exceptionally high resistance to the transverse strains. The armature cores are made of laminated sheet metal and each disk is japanned to reduce eddy currents to a minimum. Fiber disks at both ends protect the coils where they enter and leave the slots. Figs. 1 and 2 show the unobstructed air spaces which have been provided in the armature with no points where air pockets can be formed. The multi-blade fan shown at the right-hand end of the armature draws cool air through all of the interior parts. The armature coils are formed and taped before they are laid in the slots, and all of the coils are treated with an insulating varnish, and then baked.

The commutators are made of a large number of hard drawn copper bars of high conductivity which are assembled under pressure and locked by bolts. They are heat-treated and subjected to increasing pressure until the commutator becomes entirely solid. The mica insulation between the bars is of a grade which wears evenly with the copper; and this feature, together with the great rigidity of the commutator, prevents any possibility of the mica insulations working their way above the sections of the commutator. Box type brush holders are employed with radial brush feed; and they need not be reversed nor the connections disturbed when changing the direction of rotation. Flexible terminal leads are carried through the frame by insulating bushings, and the connection terminals are soldered onto the ends of the leads to receive the feed wires. When it is required to change the direction of rotation, it is merely necessary to rearrange the external leads, no adjustment of the internal connections or reversal of the brush holders being necessary.

W. P. DAVIS CUTTING-OFF MACHINE

For use in the manufacture of shrapnel shells, the W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y., has redesigned the 4½ and 6 inch cutting-off machines of its manufacture to adapt them for the rapid cutting off of blanks from round stock, and for trimming the rough edges of forgings. The frame of the machine is cast in one piece, and the spindle bearing is a part of the main casting. This makes an exceptionally rigid construction. The supports for the cutting-off slide are large pads which are cast on the frame, providing ample support for the slide and preventing the tools from chattering. The end of the bed is open to facilitate the removal of chips and the bottom of the bed is inclined to drain all of the cutting compound.

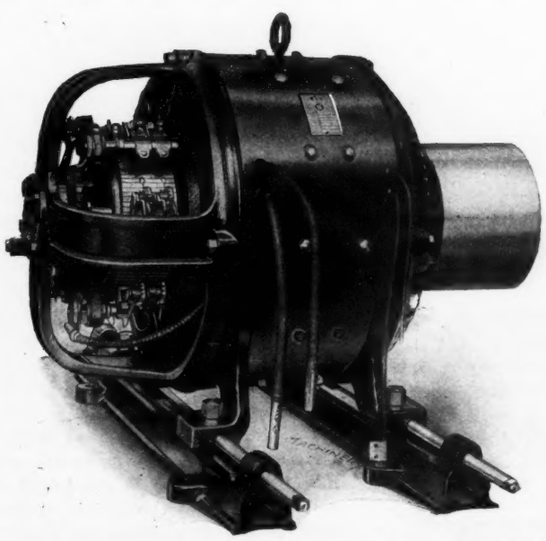


Fig. 3. The Eck Type D Direct-current Motor

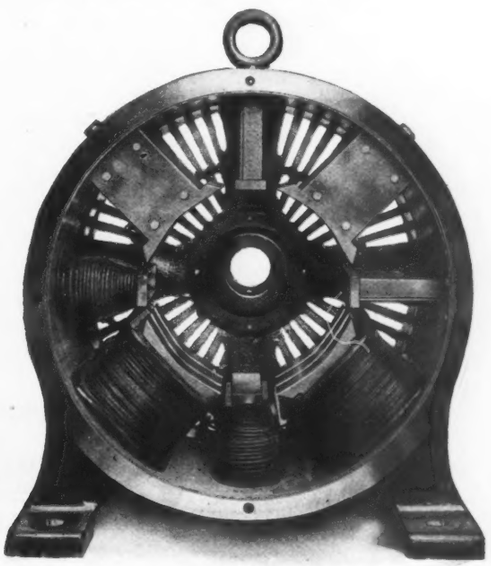
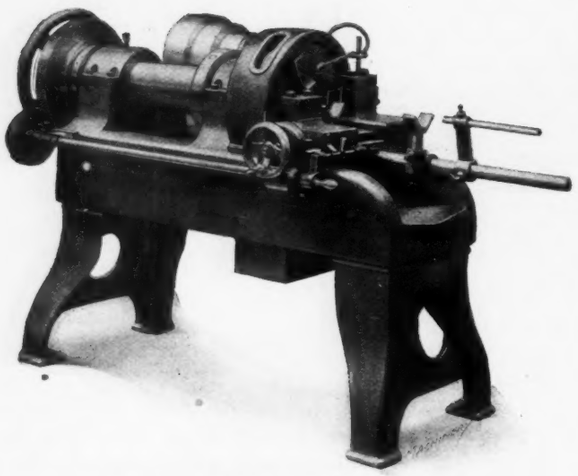


Fig. 4. Interior of the Frame



W. P. Davis Shrapnel Shell Cutting-off Machine

The spindle runs in bearings lined with anti-friction metal. There is a collar just behind the front bearing, through which four round-nosed bolts project. These bolts are intended to support the work when pieces are being cut which are too short to be gripped in the rear chuck. A heavy pattern three-jaw chuck is mounted at the front of the spindle, and there is a quick-acting scroll chuck at the rear which is operated by a handwheel. The cut-off slide is provided with two tools; and it has power feed and an automatic trip which acts when the tools reach the center of the work. A stock limit gage is mounted on this slide. No accelerating apparatus has been attached to the machine, as the four-step cone pulley and a double-friction countershaft provide sufficient additional speed as the cutters approach the center of the work, thus maintaining an efficient rate of cutting.

J. G. Blount Motor-driven Speed Lathe

by means of a screw to enable the belt tension to be adjusted. It will be seen that the motor shaft and lathe spindle carry four-step cone pulleys which give the same variation as when a countershaft is employed; and by using different sized cones, a wide range of speeds may be obtained. The lathe spindle is made of high-carbon steel; it is accurately ground to size and runs in self-oiling bronze-bushed bearings. The tailstock has screw and lever feed. The bed is cross braced and all clamping levers are located above the ways.

H. D. Smith Slot-cutting Pliers with the "Enchased Joint"

SMITH "ENCHASED JOINT" PLIERS

The feature of the slot-cutting pliers shown in the accompanying illustration is the provision of what is styled an "enchased joint." This joint provides a bearing around its entire circumferance with the exception of the points where slots are provided to form the cutters. It is claimed that this joint is stronger than either the riveted lap-joint or the box-joint constructions which are commonly employed on this class of tools. With the enchased joint the pliers would operate satisfactorily without the central rivet, but the rivet is provided in order to give additional strength and durability. These pliers are made in 6-, 8-, and 10-inch sizes by the H. D. Smith & Co., Plantsville, Conn.; and it is planned to use the same form of joint on the side cutting pliers and diagonal cutting pliers of this company's manufacture.

BLOUNT MOTOR-DRIVEN LATHE

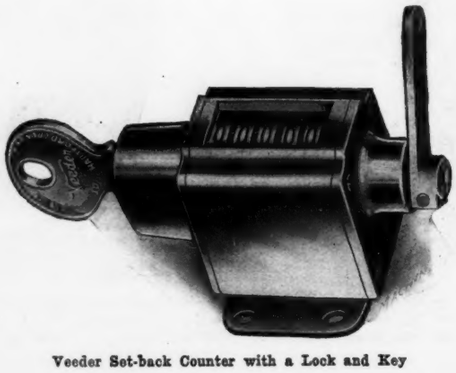
The motor-driven speed lathe which forms the subject of this article is one of the latest products of the J. G. Blount Co., Everett, Mass. A constant speed motor is employed, which is mounted on a plate provided with an extension arm to support a bearing for the outer end of the motor shaft. The motor plate is fitted to a slide on a shelf fastened to the back of the lathe bed; and the position of the motor plate and motor on this slide is regulated

VEEDER SET-BACK COUNTER

The Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn., is now making the zero re-set counter which is shown in the accompanying illustration. This instrument is particularly adapted for recording the production of all kinds of automatic machinery. It is a ratchet counter and indicates one for each oscillation of the lever, which moves through an angle of about 45 degrees. The counter is made with 3-, 4- or 5-figure wheels, and can be set back to zero by one turn of a knob, provided for the purpose. The instrument shown in the illustration is provided with a lock and key to prevent unauthorized persons from tampering with the re-setting device. The same form of instrument is made without the lock; and another instrument of similar design is made with a thumb lever with which it is operated by hand.

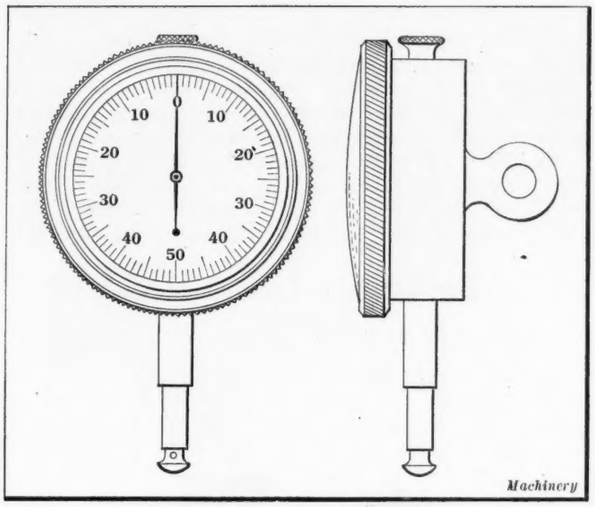
RANDALL DIAL GAGE

The design of the dial gage shown in the accompanying illustration has been worked out with the view of attaining the greatest possible simplicity of construction. Two advantages are obtained from this course. The gage has a small number of parts which means that there is less liability for it to get out of repair; and at the same time, it is possible to make gages of this form to meet the demand for relatively inexpensive instruments.



Veeder Set-back Counter with a Lock and Key

The diameter of the head of this indicator is 2⅛ inches over-all, and the dial is 1⅝ inch in diameter. It will be seen that the dial is divided into 100 spaces which are graduated from zero to 50 in both directions; but when so desired, dials can be



Front and Side Views of the Randall Dial Gage

furnished with graduations reading from zero to 100. Each division represents 0.001 inch, but the indicator can also be furnished with metric graduations. The dial is "friction tight" in the case so that it may be revolved to bring the zero into coincidence with the needle in any position that happens to bring the indicator point into contact with the work.

The spindle has a travel of 0.5 inch and may be fitted with either a button or point as desired. The back of the head is fitted with a lug through which there is a ¼-inch hole for use in attaching the head to special fixtures; it can also be mounted by the stem. With either of these methods of attachment, a mount can easily be devised so that almost any kind or size of work can be quickly and accurately measured. This instrument is applicable for a great variety of work and will be found particularly useful as an attachment to the surface gage, and as an indicator. It is manufactured by Frank E. Randall, 248 Ash St., Waltham, Mass.

TATE-JONES SHRAPNEL "NOSING" FURNACE

The accompanying illustrations show a furnace which may be heated by either gas or oil burners, made by Tate-Jones & Co., Inc., Pittsburgh, Pa. It is used for heating shrapnel shells preparatory to the performance of the "nosing" operation, and has a heating chamber 50 inches in length, and provides for heating 3½-inch blanks for a length of 6 inches. It will be seen that there are eight openings to receive the shells, and these openings are arranged in a water jacket so that the work is not heated farther back than necessary. Three burners are used in order to distribute the heat evenly and also to enable the heating to be done quite rapidly. The furnaces can be built in different lengths, depending upon the number of shells which it is desired to handle at a time; and it will be evident from the cross-sectional view shown in Fig. 2, that provision is made for adjusting the position of the water jacket in order to regulate the length of shell which is exposed to the heat.

It will also be noticed from the cross-sectional view that the vents are located directly above the shells so that the heat leaves the furnace at the top, thus avoiding discomfort which would otherwise be experienced by the workmen in removing the heated shells and replacing fresh blanks in the holes in the water jacket. The furnaces can be built in different sizes to accommodate different numbers of shells, and also for shells of different sizes. A heavy lining is provided to withstand the high temperature of the furnace; and corundite brick is used opposite the burners, as this material is found to outwear the average firebrick when exposed to very high temperatures. The front and back walls of the furnace are lined with Armstrong "nonpareil" insulating brick between the firebrick and the cast-iron frame of the furnace, as this material is found to be particularly efficient in reducing radiation losses to a minimum.

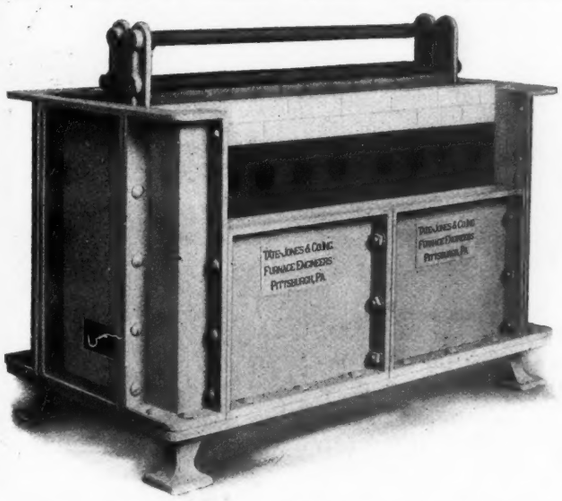


Fig. 1. Tate-Jones Furnace for Use in "Nosing" Shrapnel Shells

DALTON 6-INCH LATHE

The Dalton Machine Co., Inc., 1901-1915 Park Ave., New York City, is now building a 6-inch lathe which has the countershaft carried on an upright secured to the lathe bed, making the machine self-contained. Reference to Fig. 1 will show that this countershaft is provided with two driving pulleys, one of which carries an open and the other a crossed belt. These pulleys run loose on the countershaft and either pulley may be engaged with the shaft by means of a friction clutch, thus providing forward or reverse rotation of the lathe spindle. The clutches are controlled by means of the handle shown at the right-hand end of the countershaft, and the design is arranged in such a way that the handle may be located in the position shown, or it may be placed at the left-hand end of the countershaft.

The design of the friction clutches used on this machine is somewhat unusual and is shown in detail in Fig. 2. It will be seen that this is the ring type of friction clutch, but the design has been worked out so that the entire clutch member *A* is made in a single piece. A tapered collar on the clutch operating rod engages the lever *B* of Fig. 2, causing this lever to swing on its pivot and expand the clutch ring to engage the friction surface on the inside of the pulley. When the clutch-rod is moved back so that the tapered collar releases lever *B*, the clutch ring springs away from the pulley to

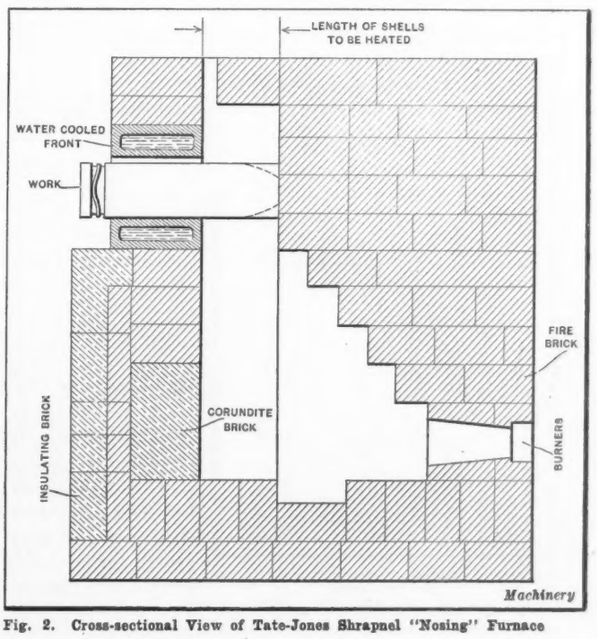


Fig. 2. Cross-sectional View of Tate-Jones Shrapnel "Nosing" Furnace

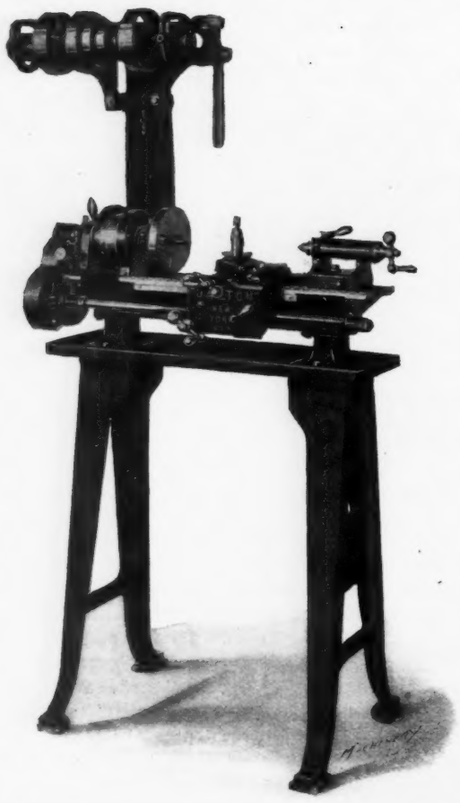


Fig. 1. The Dalton 6-inch Lathe with a Self-contained Countershaft

release the drive. The two clutches are controlled by a pair of tapered collars, so arranged on the clutch-rod that when one clutch is released, the other is engaged by continuing the movement of the clutch lever. In this way the reversal of the lathe is accomplished with a minimum loss of time. The two clutches cannot both be engaged at the same time, and there is a neutral position in which neither of the clutches is engaged.

The bracket which carries the countershaft is secured to the upright by means of four bolts, which fit in elongated holes. To adjust the belt tension, these bolts are loosened and the countershaft bracket is then raised or lowered by means of a bolt which is carried by the upright and bears against the bottom of the countershaft bracket. When the desired belt tension has been obtained, the four bolts are retightened to secure the bracket to the upright. This provides an accurate method of adjusting the belt tension, which is of considerable importance owing to the short center distance between the cone pulleys on the countershaft and lathe spindle. The bolt which provides for adjusting the belt tension, and the two lower bolts which secure the countershaft bracket to the upright are shown in Fig. 1. The countershaft bearings are ring oiled, and provided with oil reservoirs of ample capacity, so that adequate lubrication is assured at all times.

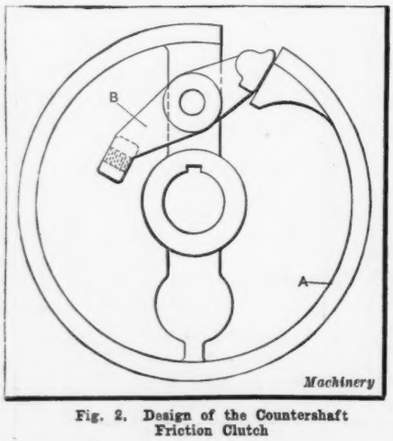


Fig. 2. Design of the Countershaft Friction Clutch

The lathe is single back geared in the ratio of 7 to 1; and power is transmitted from the spindle to the lead-screw through the usual arrangement of change gears. The lead-screw has twelve threads per inch, and change gears are provided for cutting thirty-four threads, ranging from 3 to 140 per inch, including the 11½ pipe thread. A hinged guard is provided that may be swung back to give access to the gearing when it is necessary to make adjustments of the change gears; and a brass plate at the front of this guard shows the different threads which may be obtained, and the change gears which are required to cut these threads. The principal dimensions of the machine are as follows: Maximum traverse of tailstock spindle, 3 inches; swing, 6⅛ inches; maximum distance between centers, 11 inches; weight of machine, 275 pounds.

LINDGREN HIGH-SPEED DRILL

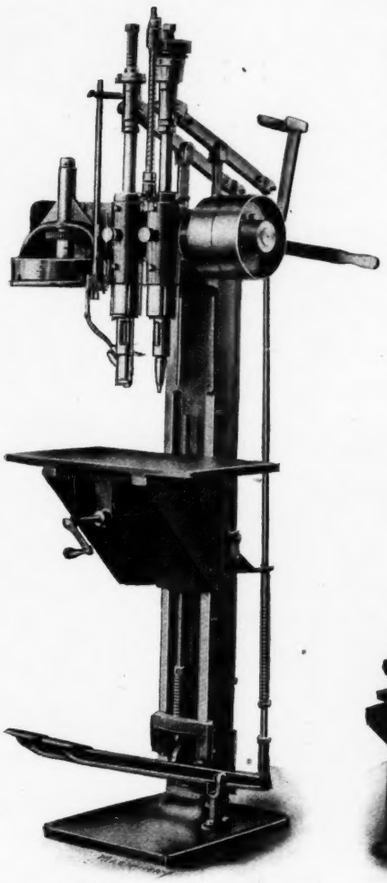
The F. W. Lindgren Co., Rockford, Ill., has recently placed a 13-inch high-speed drill upon the market which is suitable for all kinds of light drilling, and is particularly adapted for tool and die work. To provide for operation at high speed, all of the bearings are bronze bushed and equipped with ring oilers, which provide constant lubrication. When worn, the bushings can be readily replaced. The crown gear is fitted with a thrust bearing at the end of the hub, and a fiber washer prevents the escape of oil. The spindle is equipped with ball thrust bearings and the sleeve is graduated in inches. The capacity of the machine is for drills up to ⅝ inch.

F. W. Lindgren 13-inch High-Speed Drill

The principal dimensions of this new Lindgren drill are as follows: Height, 63 inches; maximum distance from spindle to base, 47 inches; maximum distance from spindle to table, 34½ inches; diameter of column, 3½ inches; size of table, 9 by 11 inches; hole in spindle, No. 1 Morse taper; width of belt on cone pulleys, 1¾ inch; width of belt on tight and loose pulleys, 1½ inch; floor space occupied, 17½ by 26½ inches; and net weight of machine, 170 pounds.

REYNOLDS SCREW DRIVING MACHINE

It is the practice in some lines of manufacturing, and especially in sewing machine work, to fasten parts together with temporary screws while certain machining and fitting operations are being performed, and then to remove these screws and insert new ones when the parts are finally assembled. To provide for the operations of removing one set of screws and inserting the other set, the Reynolds Pattern & Machine Co., Moline, Ill., has developed the machine which is illustrated and described herewith. It is similar to the standard screw driving machine which this company has been manufacturing for a number of years, so far as the screw-driving mechanism is concerned, but the present machine is provided with an auxiliary spindle which is driven left-hand. This auxiliary spindle is operated by an independent foot treadle and carries a screw-removing bit. The screw-removing bit is normally at rest, but when it is brought down by means of the foot treadle it starts to revolve and backs out the screw at high speed. The work is then moved slightly to the left and the new screw is inserted by the bit carried by the regular screw-driving spindle of the machine. The new screws are fed to the work from a magazine on the machine, which operates in the same manner as that of the standard Reynolds screw-driving machine.

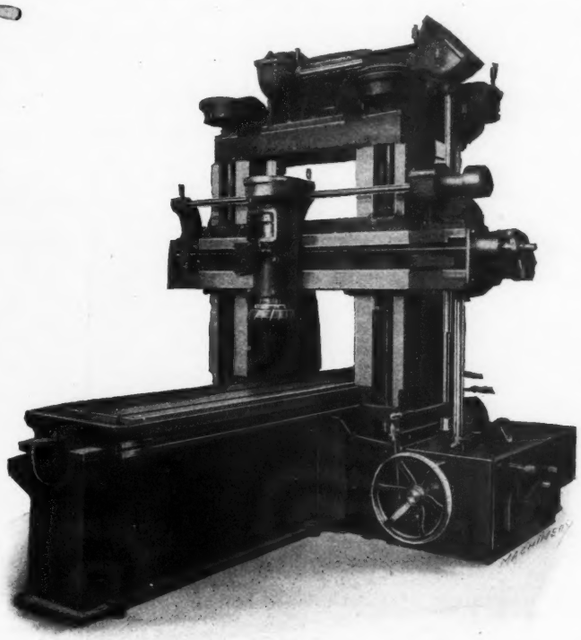


Reynolds Screw Driving and Screw Removing Machine

NEWTON VERTICAL SLABBING MACHINE

The accompanying illustration shows a vertical slabbing machine designed with single pulley drive, which is a recent addition to the line of the Newton Machine Tool Works, Inc., Twenty-third and Vine Sts., Philadelphia, Pa. In this machine, nine changes of speed are obtained through a gear box, which provides a range of from 16½ to 99 revolutions per minute. Twelve changes of reversible cross-feed on the rail are provided, in addition to reversible fast power traverse. The table has twelve changes of feed, ranging from 0.355 inch to 13 inches per minute, these changes of speed being independent of the spindle speeds. In addition, rapid power traverse at the rate of 30 feet per minute is provided in both directions. All speeds and feeds are obtained through gear boxes, which entirely enclose the gearing and are oil-tight, so that the gears may be kept flooded with lubricant. The machine will take work 34 inches wide by 36 inches high.

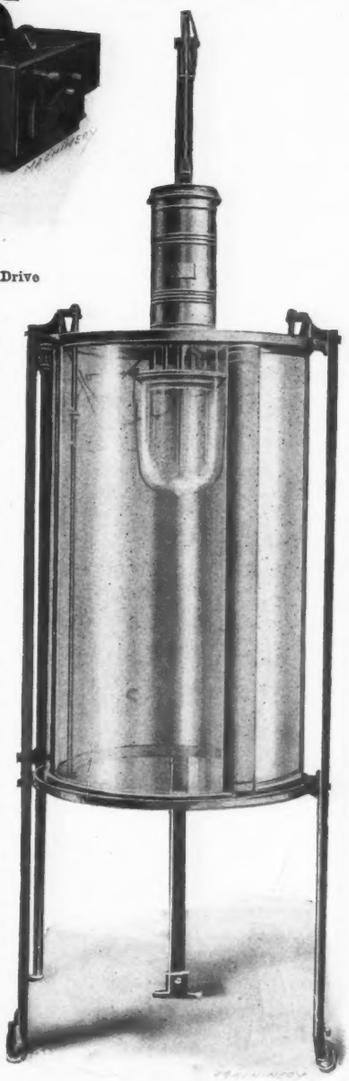
The vertical spindle is driven by a bronze worm-wheel and hardened steel worm, which is fitted with roller thrust bearings which run in oil. The spindle is 3⅛ inches in diameter, and has a No. 6 Morse taper hole in the end with a broad faced key for driving cutters. The spline shaft bushings carry auxiliary bushings which rotate with the shaft to prevent the escape of oil and preserve the fixed bushing from undue wear through contact with the spline or key-seats. The spindle sleeve is adjustable by means of a hand-controlled rack and pinion. This machine can be built with either two, three, or four spindles in addition to the single spindle type of machine which is illustrated herewith.



Newton Vertical Slabbing Machine with Single Pulley Drive

SHAW BLUE PRINT MACHINE

The accompanying illustration shows a continuous blue-print machine which has been placed upon the market by the Shaw Blue Print Machine Co., 9-13 Campbell St., Newark, N. J. This machine is known as the Model B, and has a capacity for making prints up to 30 by 36 inches in size. The machine is entirely self-contained and automatic in operation. It is suitable for use in making blue, black, Van Dyke and direct process prints; and prints of any length may be made in one piece. These machines are equipped to operate on any electric current which is available in the drafting-room where they are to be used. It will be evident to the reader that this machine is of the vertical cylindrical type. The way in which the arc light is supported and the general features of the design will be readily apparent from the illustration.



Shaw Continuous Blue Printing Machine

ALLEN-BRADLEY STARTING SWITCHES

It is frequently desirable to start small alternating-current motors from a distance by means of a push button or some other contact-making device; and to meet the demands of such service the Allen-Bradley Co., Milwaukee, Wis., has developed a line of automatic starting switches for single and polyphase squirrel cage induction motors, which can be thrown directly across the line. These automatic starting switches are intended for the remote control of motors driving fans, ventilators, pumps, drill presses, lathes or other kinds of machine tools. In designing these self-starters great care has been taken to have them as noiseless in operation as is possible. The plain automatic starting switch, illustrated in Fig. 1, consists of a two-pole, magnetically operated, clapper-switch mounted on a slate panel. The clappers are held in the closed position by the magnetic pull of the electromagnet, the terminals of which are connected to the line.

This electro-magnet is designed for continuous service and exerts a sufficient pull to insure a good contact of the clappers. Since the circuit to the motor is opened immediately the electromagnet is de-energized, this starter affords full no-voltage protection. Ample overload carrying-capacity is provided; and all switches, with the exception of the very smallest, are provided with a magnetic blowout. The contacts of the clappers are made of hard drawn copper. They are so shaped and pivoted on a shaft, that in closing the switch, a long roll contact is effected. The magnetic circuit is built up of sheet steel laminations and is provided with a shading coil which makes the starter practically noiseless. Careful attention has also been paid to the power consumption of the switch in its closed position, with the result that it has been reduced to a minimum and is too small to be worthy of consideration. The switch is extremely quick and snappy in closing and opening the circuit, which makes its arc disrupting-capacity very great, and, furthermore, materially reduces the expense of replacing contacts. All parts of the apparatus are readily accessible and the contacts can be easily cleaned.

The type-E automatic starting switch for small alternating-current motors is built in several forms. Fig. 2 illustrates the most complete type. This automatic starter is provided with two adjustable time-limit overload relays, line knife switch and fuses, which equipment absolutely protects the motor against burnouts. Another form of this starter consists of a combination of the automatic switch itself with the line switch and fuses, while in still another form the two time limit overload relays are substituted for the switch panel. All of these forms are very compact, and because of their variety, make it possible to equip the motor with the starter that is best suited to the existing operating conditions. Some kind of a contact-making device such as a push button, snap switch, gage type pressure regulator, float switch

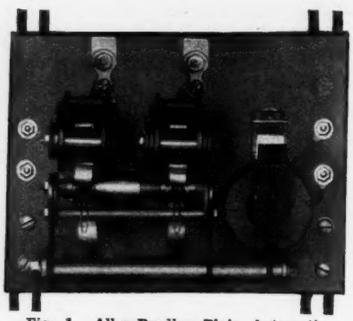


Fig. 1. Allen-Bradley Plain Automatic Starting Switch

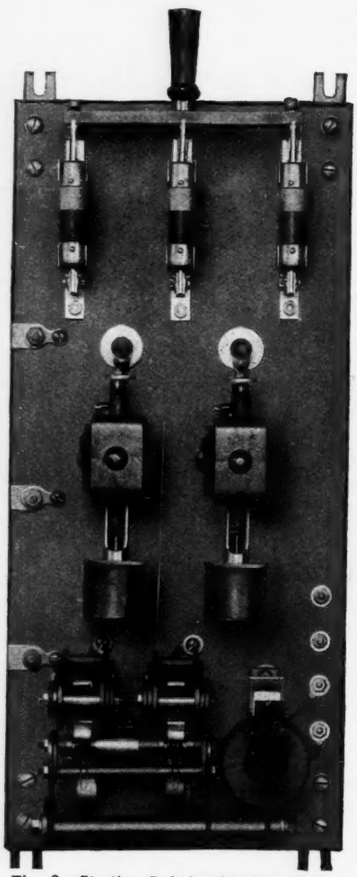


Fig. 2. Starting Switch with Line Knife Switch, Fuses and Two Time-Limit Overload Relays

United States Bench Drill

or similar apparatus is necessary for the operation of this starter. When the line contacts are closed, which in the case of the push button is done by pressing the starting button, the coil of the clapper switch, which acts as an electromagnet, is energized and its magnetic pull immediately closes the clappers of the starter. These clappers connect the motor directly to the line.

Although these automatic starters can be used in connection with either a two- or three-wire push button system, it is to be recommended that the three-wire system be given the preference because it permits the multiple station control of a motor, while its protective features are also greater. Of course, where float switches, pressure regulators or thermostats control the operation of the starter, only the two-wire system can be used. Although the remote control of small alternating current motors used on machine tools has never been given the same attention as has been devoted to this branch of direct-current electricity, experiments and practical applications have conclusively proven that the same economies are effected, and the productive capacity of the equipment increased.

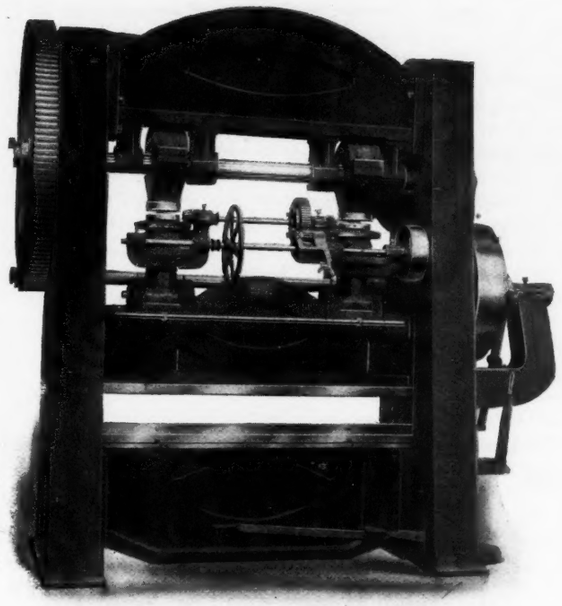
UNITED STATES BENCH DRILL

One of the recent products of the United States Electrical Tool Co., Sixth Ave. and Mount Hope St., Cincinnati, Ohio, is an electric bench drill which is driven by a motor provided with a cord for making connection with an ordinary lamp socket. Motors are provided to take power from 110 or 220 volt circuits of either alterating or direct current. When so desired, the drill can be taken out of the frame and used as a portable tool. The capacity is for driving drills up to ¼ inch in diameter.

There are many shops in which a convertible tool of this nature can be used to advantage. When mounted in the stand, as shown in the accompanying illustration, it is suitable for various classes of light drilling; but in those shops where there is not enough work of this character to keep the tool busy, the drill can be removed from the stand, have the handle attached to it and be used for any of the numerous purposes for which a portable electric drill is adapted. The handle, which is not shown in the illustration, forms part of the regular equipment of the tool.

BERTSCH BENDING BRAKE

The accompanying illustration shows a bending brake which is a recent product of Bertsch & Co., Cambridge City, Ind. This machine has a capacity for bending plates up to ¼ inch in thickness, and is built in different sizes with from 6 to 12 feet between the housings. The pressure capacity of the different sized machines is up to 100 tons. The drive is through a friction clutch that is so controlled that the slide head can be instantly stopped at any point in the stroke; and the head is adjusted by either hand or power. This machine was particularly designed for use in the manufacture of fire-proof doors, windows, par-



Bertsch Bending Brake with a Capacity for Plates up to ¼ inch Thick

titions, and trimming; and it is also well suited for use in the manufacture of general classes of sheet metal products such as metal furniture, lockers, shelving, etc. The machine can also be equipped for gang punching operations.

* * *

NEW MACHINERY AND TOOLS NOTES

Ratchet Wrench: Chicago Mfg. & Distributing Co., Chicago, Ill. A combination wrench and drill capable of holding round or square taper-shank tools from 1/4 to 9/32 inch in diameter. The wrench is intended for use in connection with a drill post.

Straightening Machine: Abramsen Engineering Co., Pittsburg, Pa. A machine for straightening rods, bars and pipe which will straighten the work by a single pass through the machine. These machines are built in sizes to handle material from ⅜ to 6 inches in diameter.

Combination Tool-holder: Duckett Tool & Mfg. Co., Detroit, Mich. The important feature of this tool-holder is that the socket in which the cutter is carried may be swiveled to any required angle in relation to the shank of the tool-holder, and held in this position by tightening the binding screw.

Baling Press: Tempus Reclaiming & Mfg. Co., Philadelphia, Pa. A machine for compressing scrap metal into bundles, which can be conveniently packed for remelting. This is a stationary machine and compresses the scrap into cylindrical bundles 18 inches in diameter by 26 inches long.

Radial Drill: Almond Mfg. Co., Cleveland, Ohio. This is the same machine which was illustrated and described in the June, 1914, number of MACHINERY, except that it is provided with a base upon which the radial arm is mounted instead of having the arm secured to a post or to the wall of the building.

Grinding and Polishing Machine: C. L. Hawes, Ashtabula, Ohio. This machine is adapted for all classes of grinding and polishing where speeds from 1800 to 3600 R. P. M. can be used. It carries wheels from 6 to 14 inches in diameter; and guards are provided over all danger points—hence the name, "safety first" grinder.

Driving Wheel Lathe: Niles Tool Works Co., Hamilton, Ohio. This lathe swings up to 100 inches, and the design follows the general lines of the standard 90-inch tool of this company's manufacture. The range is for wheels from 32.7 to 94½ inches in diameter on the tread, with a maximum distance between centers of 11 feet 2¼ inches.

Reverse Gear: Carlyle Johnson Machine Co., Manchester, Conn. This gear is applicable for use on all types of machinery where reversal of the spindle is required, as in the case of the tapping machine. The design is such that the reverse gear can be applied to the driving mechanism of machines to provide for reversal of the spindle.

Riveting Machine: Barnes & Kobert Mfg. Co., Milldale, Conn. An electrical riveting and forging machine which is provided with an electrically heated die which brings the head of the rivet to a forging temperature, and the punch which performs the riveting operation. Working under practical conditions, only five seconds is required to bring a ⅝ inch rivet to the forging temperature.

Motor-driven Screw-driver: United States Electrical Tool Co., Sixth Ave. and Mt. Hope St., Cincinnati, Ohio. This tool has been developed to save time in driving wood or lag screws or screwing nuts onto bolts. The tool is driven by a universal motor which may be operated on either direct or alternating current, and a friction clutch with a spring release controls the starting and stopping of the bit.

Multiple-spindle Boring Machine: Reynolds Pattern & Machine Co., Moline, Ill. A multiple-spindle machine adapted for wood boring and light metal drilling. The spindles are adjustable so that they can reach any point between the housings of the machine. The drill spindles are carried by brackets which can be swiveled through a complete revolution, so that the drills reach over an area of considerable width.

Gear Shaping Machine: Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt. With the exception of the work spindle construction used on this machine, the design is similar to that of the other standard gear shapers of this company's manufacture. The machine is designed primarily for cutting the teeth of shaper bull-gears and lathe back-gears. The spindle is hollow, and made large enough to accommodate the large gear while the pinion is being cut.

Portable Electric Tools: Van Dorn Electric Tool Co., Cleveland, Ohio. This company has recently brought out a combination drilling and grinding machine, and a high-speed universal electric drilling machine. The first machine referred to may be used as a portable tool or it may be mounted on a bench stand. The high-speed universal drill is intended for the regular classes of work for which a portable tool of this character is ordinarily employed.

Cartridge Case Finishing Machine: Bullard Machine Tool Co., Bridgeport, Conn. It is claimed that this is the only machine upon the market which is designed in such a way that the mouth-boring operation is included. The essential features of this machine are those of a four-faced turret and cross-slide machine, on which are mounted the tools required for machining the head or flange-end of the case, with the addition of means for the mouth-boring and trimming operations.

Combination Internal and External Grinder: Hisey-Wolf Machine Co., Cincinnati, Ohio. This little machine is adapted for a wide range of work. The motor has a double set of oil cups to insure adequate lubrication at all times. A quick-acting switch fastened to the connecting cable is located at a distance of about 6 inches from the motor where it is convenient for the operator. The general features of design of this machine are similar to the regular line of portable tools of this company's manufacture.

Welding and Cutting Torch: Turner Brass Works, Sycamore, Ill. The feature of this torch is that all the valves are grouped in such a way that the torch can be operated with one hand, either valve being reached by a slight movement of the thumb or forefinger. The valves which control the oxygen jet when cutting is being done can be adjusted to a fixed position, thus avoiding the necessity of holding the valve down when long cutting operations are being done. The mixing chamber is located in the handle instead of in the head of the torch.

Cold Saw: Espen-Lucas Machine Works, Philadelphia, Pa. A cutting-off machine particularly designed for cutting off shrapnel-shell blanks from steel bars. Speed and feed variations are provided that can be used for cutting at from ½ inch to 5 inches per minute. Any amount of feed may be used as the cutting capacity of the machine is only limited by the nature of the material that is being sawed. The changes of feed are obtained through a friction plate and any change may be obtained while the machine is in operation. The saw carriage is also provided with a quick return mechanism, and an automatic stop for controlling the cut.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly on the 1st, at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Managing Editor, None	
Business Managers: Alexander Luchars, President	〃 〃 〃 〃 〃
Business Managers: M. J. O'Neill, General Manager	〃 〃 〃 〃 〃
Publisher, The Industrial Press	〃 〃 〃 〃 〃
Owners of one per cent or more of the stock:—	
The Industrial Press	〃 〃 〃 〃 〃
Alexander Luchars	〃 〃 〃 〃 〃
Matthew J. O'Neill	〃 〃 〃 〃 〃
Fred E. Rogers	〃 〃 〃 〃 〃
Louis Pelletier	〃 〃 〃 〃 〃
H. L. Brown	〃 〃 〃 〃 〃
Erik Oberg	〃 〃 〃 〃 〃

There are no bondholders, mortgagees, or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 18th day of March, 1915

HARRY B. HEALEY,

Notary Public No. 84, Kings County,

Certificate filed in New York County No. 74.

(SEAL) (My commission expires March 30, 1916.)

CONVENTION OF THE N. M. T. B. A.

The thirteenth semi-annual convention of the National Machine Tool Builders' Association was held at Atlantic City, N. J., May 20 and 21 in the Marlborough-Blenheim Hotel. President W. A. Viall of the Brown & Sharpe Mfg. Co. occupied the chair, and Charles E. Hildreth, general manager of the association, assisted in conducting the sessions. Although the attendance was below normal, those who attended were in an optimistic frame of mind, quite different from that prevailing among the members of the association a year ago. The manufacturers of lathes, turret lathes, automatics, milling machines, and other machines used in the manufacture of war munitions are very busy, many of them having orders booked months ahead. The demand for machine tools for this purpose is so heavy that there is some prospect that reviving railway business will be hampered by the inability to get machine tools required for locomotive repair work.

The usual roll-call following registration of members was omitted, as was also the reading of the minutes. After hearing the reports of committees and following other routine business, President Viall spoke of the safety and sanitation work being accomplished by the members of the association, and especially of the apprenticeship instruction work. The National Machine Tool Builders' Association has been one of the foremost in promoting apprenticeship instruction. Its apprenticeship indenture papers have served as a model for other associations. A movement is on foot to harmonize and extend the work in apprenticeship instruction among the association, and Magnus W. Alexander, of the General Electric Co., has proposed a conference board on the training of apprentices. This board will be composed of members appointed from the National Machine Tool Builders' Association, the National Association of Manufacturers, the National Metal Trades Association, the National Founders Association, and the United Typothetæ of America.

C. O. Smith, of the Norton Grinding Co., in the absence of S. H. Bullard, chairman of the committee, read the report on the proposed association card index. The catalogue idea has been abandoned, and instead it is proposed to issue an association card index which will consist of two parts. First is a subject index in which will be listed every machine tool made in America; all manufacturers of machine tools will be included regardless of association membership. The second part of the card index will consist of a manufacturers' index, and will be confined to the members of the National Machine Tool Builders' Association. These cards give the principal data of each machine, including weight, capacity, and dimensions.

Robert T. Kent, editor of *Industrial Engineering* and an efficiency engineer associated with Taylor, Gantt and others, delivered an address, "The Application and Use of Time Study Data." Mr. Kent described the system of time study applied to a certain lathe job, showing how the process of lifting a given casting into the lathe, chucking, setting the tools, turning and boring could be divided into simple elements, and the time required for each could be ascertained; then these data could be applied to other operations. Thus, with these time elements, the analysis of other jobs comprising similar operations, could be easily made, and the time required accurately fixed. With the facts obtained from time study, the fixing of rates is a comparatively simple and easy matter. Very little is left to guess-work on the part of those who have to fix the rates.

Harold C. White, superintendent of assembling of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., read a paper, "How to Profitably Operate a Night Force." Mr. White reviewed the well-known difficulties of organizing an efficient night force. The purpose of his paper was to show how these difficulties might be overcome, and good work and the same quantity of it produced by a night force as by the day force. He pointed out that the problem could be divided into three principal parts: first, time; second, labor; third, facilities. Time is fixed, there being but twenty-four hours a day, but it is possible to utilize all this time. The difficulty with labor is to secure the trained help that will work nights and produce work that will pass inspection. Labor employed at night is at a disadvantage because of the difficulty in getting meals, and of sleeping through the day. It is necessary to pay higher rates for night work, and desirable to provide hot coffee and other light refreshments. The tools require to be kept up to a high standard; it will not do to let them run down. Machines and tools are being used twice as much, and hence their wear and tear is twice as great. Mr. White pointed out that this is one reason why night work is generally regarded as productive of poor work. The upkeep is not properly attended to and machines and tools get into bad shape before the cause of the trouble is detected.

On Thursday afternoon the business of the convention was done in committee meetings, these consisting of meetings of the lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, and planing machine committees. The forenoon of Friday was also given up to committee meetings, the following committees then holding their sessions: multi-spindle drilling machine, milling machine, shaping machine, vertical drilling machine, turret lathe and radal drilling machine committees.

On Friday afternoon a paper, "Drop Forgings," by A. M. Tilton, president of the Drop Forging Co. of New York, Jersey City, N. J., was read, following which was an address on "Neutrality" by George Grafton Wilson, professor of international law, Harvard University.

* * *

SHOOP METAL SPRAYING PROCESS

The monthly meeting of the American Society of Mechanical Engineers was held at the Engineering Societies Bldg., New York City, Tuesday evening, May 11. John Calder, mechanical engineer with the Metals Coating Co. of America, read a paper: "Metal Spraying Processes in Engineering and Art" illustrated with lantern slides. A practical demonstration of the Schoop metal-coating "pistol" was given in the basement of the building, which showed that it is commercially feasible to spray objects made of metal, wood, stone, cloth, paper, etc., with brass, aluminum, copper, and lead.

Mr. Calder pointed out the great need of effective means of protecting bridges, viaducts, elevated railways and other steel structures from rust and corrosion. These structures are now protected only at great expense by painting, and painting must be frequently done to be effective. The Schoop process may be used either in the shop or in the field to deposit coatings of zinc or other metals on the parts, forming an effective rust-protecting coating. He described the inception of the process. M. Schoop, the inventor, was first led to investigate the possibilities of coating objects with pulverized metal by noting the effect of rifle bullets fired against stone walls. He concluded that an apparatus might be devised for projecting lead and other metals against walls and metal structures. The first apparatus weighed over a ton and was commercially unsatisfactory. This apparatus comprised a melting pot, the metal being in a molten condition when projected by an air-blast. The inventor concluded from his experiments that it was not necessary that the metal be molten, but that it should be in a finely divided state. His next apparatus consisted of a means for projecting finely divided metal dust. This apparatus worked but it, also, was commercially unsatisfactory. The third and successful apparatus is the Schoop pistol, weighing only about 3½ pounds. It is essentially a Bunsen flame apparatus for melting the metal and blowing it out in a finely divided state against the object to be covered. The metals used are supplied to the pistol in the form of wire, and the pistol comprises a mechanism for feeding the wire to the nozzle through which it is projected and where it comes in contact with the flame. The metal is instantly melted and then blown into fine globules against the object. The globules are given a velocity of about 3000 feet per second, and they imbed themselves into the rough surface of the oject and particles subsequently deposited interlock with those already sprayed, so that a continuous and impervious coating is formed. The coating effectually prevents the entrance of oxygen and corrosive elements in the atmosphere.

TURBO SPEED TRANSFORMER

The speed transformer which forms the subject of this article is manufactured by the Turbo-Gear Co., Industrial Bldg., Baltimore, Md., and may be used for either reducing or increasing the speed of rotation. It is called a "turbo-gear," the term being derived from the fact that this transmission is frequently used to give the required speed reduction between a steam turbine and the machine driven by it. To operate economically, a steam turbine must run at high speed and the turbo-gear is well adapted for the purpose of reducing the speed, so that it is suitable for the driven member of the unit. The same problem arises in cases of

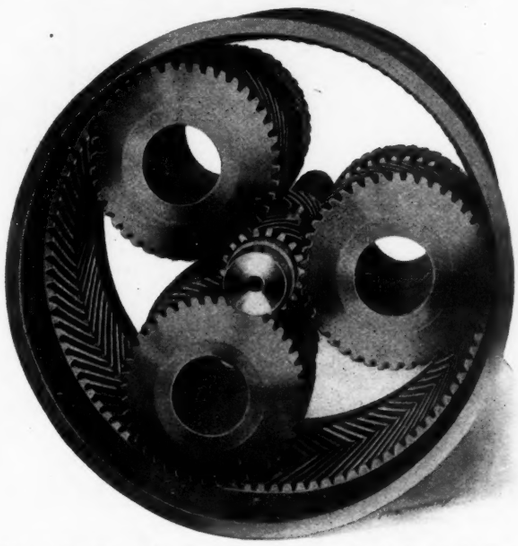


Fig. 1. Gearing of the Speed Transformer made by the Turbo-Gear Co.

electric motor drive, and in such installations, the turbo-gear is said to be giving satisfactory service. It has already been mentioned that this speed transformer can be used for either decreasing or increasing the speed of rotation, and two instances have been cited where the gear is used as a means of reduction. As an example of the use of this transformer for increasing the speed, take the case of certain steam, gas or oil engine installations which are employed to drive such high-speed machines as centrifugal pumps, blowers, etc.

The teeth of the helical gearing of this speed transformer are of the involute stub-tooth type. The large double internal helical gear is cut from an open-hearth steel forging. The double helical pinion is integral with the high-speed shaft, this pinion and shaft being made of chrome vanadium steel which has an elastic limit of 210,000 pounds per square inch. The intermediate double helical gears are made of Lumen manganese bronze, and are mounted on hardened and ground forged steel shafts which are secured to the slow speed member by means of a taper fit and Woodruff keys. The slow speed member has the slow speed shaft secured to it, and is mounted on two heavy-duty S. K. F. ball bearings. Thus the slow speed member and the shafts carrying the intermediate gears, and the high-speed shaft and pinion, are independent of each other as far as support is concerned, each being held directly by the housing.

Both the high-speed shaft and pinion, and the slow speed member which carries the intermediate gears, are accurately ground all over and carefully balanced before the speed transformer is assembled. The housing is made of gray cast iron and is split horizontally to afford access to all internal parts. The housing is heavily constructed and ribbed to provide a rigid support for all of the gear members. The high-speed shaft has a central passage through which oil is pumped, and a continuous stream of oil is sprayed onto the gears through radial passages in the pinion. In addition to forced feed lubrication, the high-speed bearings are provided with oil-rings and reservoirs of liberal capacity for emergency use. The superfluous oil from the high-speed bearings is collected by a centrifugal oil-ring and forced through the hollow shafts which carry the intermediate gears. After lubricating the bearings and gears, the oil is drained to the main reservoir in the base of the housing, where it is strained, cooled and returned to the pump, ready for subsequent use. From this description, it will be evident that the gears do not run in oil so that the loss of efficiency is avoided, due to back pressure resulting from this cause. It is claimed that the turbo-gear has a transmission efficiency of 95 per cent.

* * *

SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held in Buffalo, N. Y., June 22 to 25, inclusive. The headquarters during the meeting will be at the Hotel Statler, where most of the sessions and entertainments will be held. One day will be spent at Niagara Falls, the morning session being in the large auditorium of the Shredded Wheat Biscuit Co. The afternoon will be devoted to an inspection of some of the Niagara Falls plants, including the famous Niagara power plants. Many other large plants in Buffalo and vicinity will be open for inspection, including among others, the Buffalo Foundry & Machine Co., Lackawanna Steel Co., Wickwire Steel Co., Snow Steam Pump Works, Pierce-Arrow Motor Car Co., Buffalo Forge Co., Simonds Mfg. Co., etc.

The entertainment of the visiting members will, as usual, be in the hands of a local committee, of which David Bell is chairman. The Engineering Society of Buffalo will cooperate with the Buffalo Society of the A. S. M. E. in extending a welcome to visiting members and showing them features of special engineering interest. The papers to be presented include the following:

"Laps and Lapping," by W. A. Knight and A. A. Case.

"Model Experiments and the Forms of Empirical Equations," by E. Buckingham.

"Rational Design and Analysis of Heat Transfer Apparatus," by E. E. Wilson.

"Influence of Disk Friction on Turbine Pump Design," by F. zur Nedden.

"A Study of an Axle Shaft for a Motor Truck," by John Younger.

"Corrugated Furnaces for Vertical Fire Tube Boilers," by F. W. Dean.

"The Effect of Relative Humidity on an Oak Tanned Leather Belt," by William W. Bird and Francis W. Roys.

"The Relation Between Production and Costs," by H. L. Gantt.

"Design of Rectangular Concrete Beams," by Howard Harding.

"Some Mechanical Features of the Hydration of Portland Cement and the Making of Concrete as Revealed by Microscopic Study," by Nathan C. Johnson.

"Surface Condensers," by Carl F. Braun.

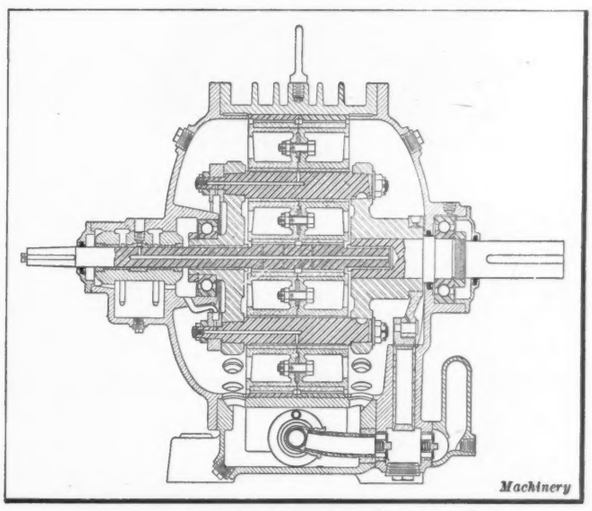
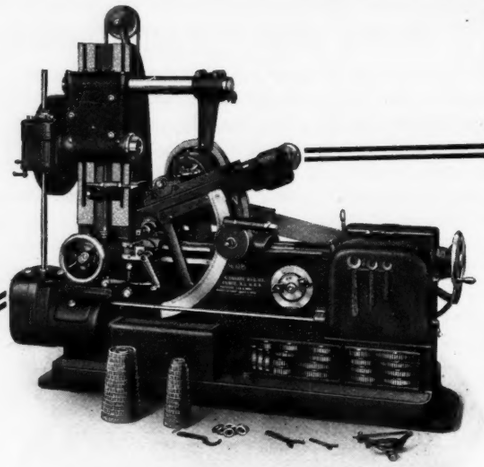
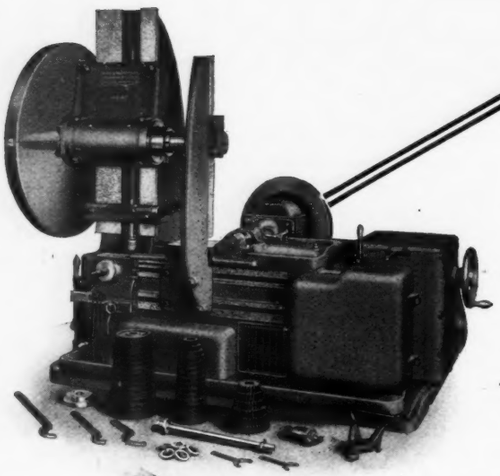


Fig. 2. Cross-sectional View of the Turbo-Gear Co.'s Speed Transformer

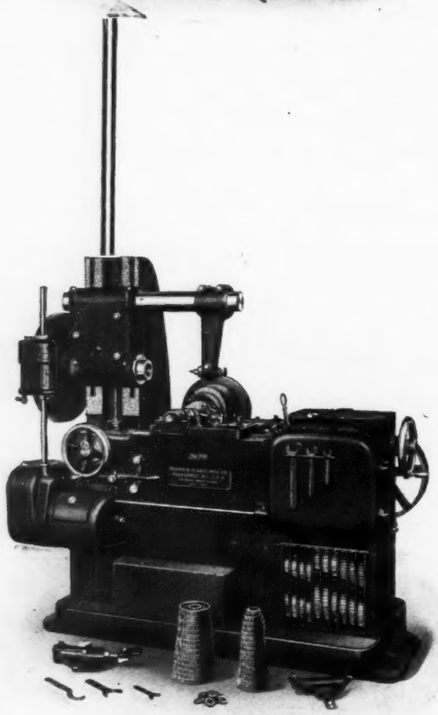


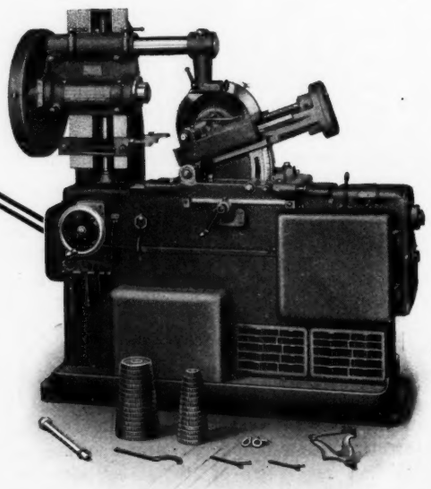


4

Efficient Machines From Our Line of Gear Cutting Equipment

Four representatives from our line of eight automatic gear cutting machines are shown herewith. Those directly above and below are for spur and bevel gears; those at the side are for spur gears only. All are well worth considering.





4 Reasons Why You Should Consider These Machines

They are Easy to Set Up—Handy to Operate

That is where our machines start right—they find favor with the operator. The simplicity of design makes it easy to get a quick start on every job. All operating parts are within easy reach and there is no complex mechanism to cause confusion or loss of time. Setting-up time—non-productive time—is reduced to a minimum, and efficient results are attained with little attention from the operator.

They Produce Work Rapidly and Accurately

That's where these machines score with your production men. They know what can be expected and how well these machines can be relied upon for fast production on all kinds of work. For fast roughing and accurate finishing such features as the rapid and efficient indexing mechanism, the large accurate index wheel, the smooth and powerful drive to the cutter spindle, the reduction of time of idle movements to a minimum, and the general stability to withstand heavy manufacturing service create a feeling of confidence.

They Keep Your Gear Costs Uniform and Low

This interests every owner, manager and superintendent. It is the final test of a machine's worth—what it can produce and how much it costs for such production. On manufacturing jobs a man can run more than one machine which, coupled with quick setting up and fast production, means low costs. Then the fact that the same satisfactory production conditions can always be secured insures uniformity in costs.

They Give Such Service for Many Years

This determines the ultimate wisdom of an investment and shows the real economy of a machine. Like all our machine tools, B. & S. Automatic Gear Cutting Machines are built with this end in view. In addition to the efficient operating and production features, the solid construction, the high quality materials, the careful workmanship and the rigid inspection insure long life and good service. Write for descriptive circulars.

Brown & Sharpe Manufacturing Co.

Providence, R. I., U. S. A.

READ PAGE 71

BALL BEARINGS*

POINTS OF CARDINAL IMPORTANCE IN THE DESIGN AND OPERATION OF BALL BEARINGS

THE anti-friction qualities of ball bearings have long been known, but until recent years the ball bearings actually devised have been unreliable. While they lasted, they ran well, but they broke down too easily, the principal reasons being faulty design, the use of steels that were insufficiently hard and lacking in uniformity, and inaccuracies of size and form which resulted in unequal loading of some of the balls and the consequent destruction of those overloaded. One of the earliest investigators to conduct a systematic research into the subject of ball bearing design was Prof. Stribeck of the Technical Laboratories in Neubabelsberg, Germany. From his experiments, Stribeck developed the following equation for the carrying capacity of an annular or radial bearing:

$$P = \frac{KD^2N}{5}.$$

Where P = carrying capacity of bearing in pounds;

D = ball diameter in eighths of an inch, *i. e.*, for a ball ½ inch in diameter, $D = 4$;

N = number of balls in the bearing;

K = a constant dependent upon the material, the shape of the ball supporting surfaces, and the speed.

This is the commonly accepted equation for determining the carrying capacity of a radial bearing, and one that is generally made use of by those exponents of the theory that the carrying capacity of a bearing is directly proportional to the number of balls contained. Other things being equal, this would be true, but it must be borne in mind that the race cross-section also plays a vital part in determining the carrying capacity of a bearing. Any device that may be employed for the insertion of a larger number of balls than can be gotten into the bearing by eccentric displacement, such as filling slots, making one side of the race groove shallow, etc., weakens the race and hence results in a decreased carrying capacity. A bearing with continuous rings, deep ball grooves, and as many balls as can be inserted without forcing, proves the best. These stiff rings are susceptible of extreme accuracy of manufacture and maintained accuracy in service, even though they are mounted in slightly out of round housings.

The problem of producing a successful ball bearing was not solved with the adoption of the proper cross-section and form; truth of shape is necessary to true rolling action and the avoidance of sliding. Loading must inevitably cause some distortion and so introduce sliding action. This sliding action must be minimized by using materials sufficiently elastic to avoid permanent deformation. This demands the use of steels of the very highest grade, which have been most carefully hardened, and eliminates all case-hardened materials. These demands made on the ball material are made on the race materials in even higher degree. In time, the entire surface of the ball is presented to the load, vibration or change of load, either in amount or direction, sufficing to frequently bring in a new axis of rotation. As one of the races is usually fixed, it always presents the same point to the action of the load. It may safely be said that only the advent of high-grade alloy steels has made the ball bearing possible as a heavy load-bearing machine element.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

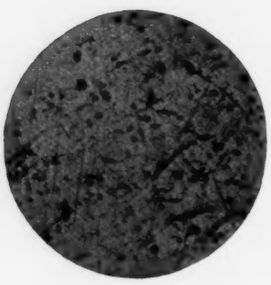


Fig. 6

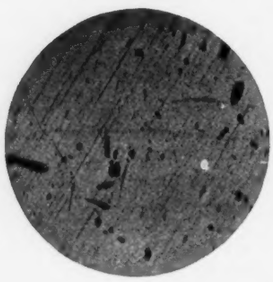


Fig. 7

Fig. 8

Figs. 1 to 8. Reproductions of Microphotographs of Ball Surfaces magnified 120 Diameters, showing Various Degrees of Perfection attained in the Grinding and Polishing Operations. Fig. 5 shows the Finish of Balls used in Hess-Bright Bearings

Ball bearings are being used with satisfaction in automobiles, electrical, flour, and woodworking machinery, in street railway motors, on street and steam railway main axle-journals, in line shaft hangers, and in countless other applications where power economy and freedom from wear are desired. Naturally, satisfactory service from a ball bearing can only be secured when the bearing is designed to conform to the service for which it is intended. The elements entering into such design are the direction of the load, *i.e.*, whether at right angles (radial) to the shaft, parallel with it (thrust) or acting at an angle. Within each type, sizes are affected by the loads and by the speeds. Bearings are further affected in their relative arrangement, by varying combinations of load-direction, and by the load and speed.

In bearings for carrying radial loads, resistance to the shock of a given load is greater, the greater the ball diameter. When shock is present, of two bearings having the same carrying capacity, that having the larger balls should be used. Radial bearings, as commercially manufactured, are made up in three series, *i.e.*, light, medium, and heavy weight series. Thus, for a given bearing bore, a choice between three sizes of bearings of increasing capacity and ball diameter is afforded. Radial bearings are capable of carrying considerable thrust load, amounting, in bearings with deep race grooves, to about 25 per cent of their rated radial capacity.

* Abstract of a paper by B. D. Gray, vice-president and manager of the Hess-Bright Mfg. Co., Philadelphia, Pa., read before the meeting of the Electric Vehicle Association of America, in Philadelphia, Pa., on April 14, 1915.

The CINCINNATI No. 5

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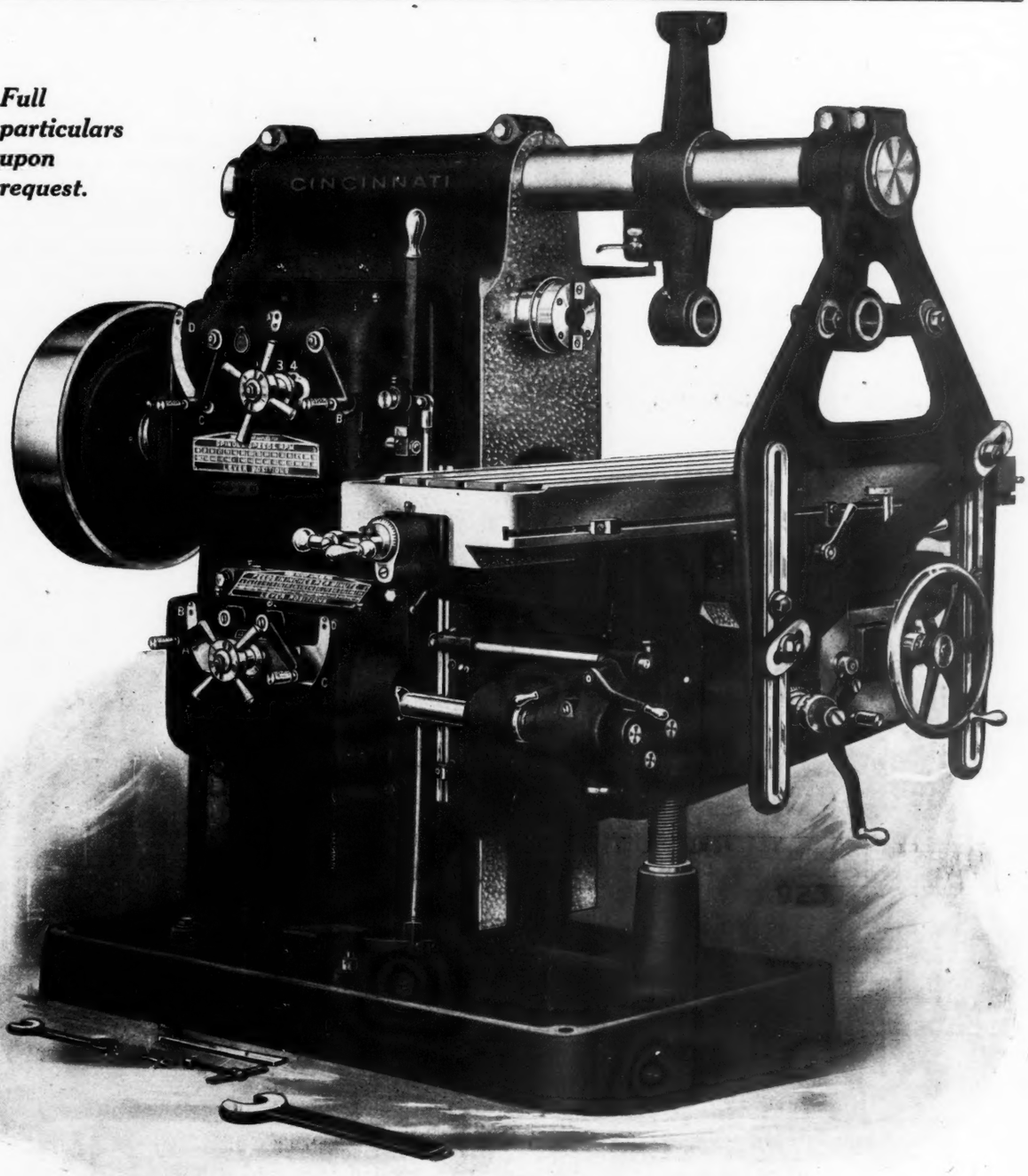

RANGE: Power Travel Feed 50"; Power Cross Feed 14"; Power Vertical Feed 21". Pieces 36⅜" wide can be passed between face of column and braces. 20 Horse Power.

THE CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio

Where it seems desirable to subject radial bearings to a thrust load, it is advisable to consult with the bearing manufacturer.

It may be stated as an axiom in ball bearing manufacture that "the value of a ball bearing is in direct ratio to the accuracy attained in the manufacture of its component parts, and the suitability of the material entering into them." The limits of tolerance are much smaller than are generally considered feasible. The finish of the working surfaces of the balls and races must be of the highest. Grinding or polishing marks that may be detected by the naked eye condemn balls and the ball tracks utterly. Oft-repeated endurance tests under conditions where the finish was the only variable, abundantly proved this, at first unsuspected, fact. The higher the finish, the better the endurance of the bearing. Microphotographs of ball surfaces reveal that what appears to be an absolutely flawless surface is in reality composed of fine scratches, pittings and even gash-like defects (see Figs. 1 to 8) according to the care devoted to the final operation. Mere polish alone will not do; the polish must be the final touch applied to truly ground shapes.

TABLE SHOWING RESULTS OF TESTS OF CARRYING CAPACITIES OF DIFFERENT SHAPED BALL TRACKS

Disk Surface	Pressure in Pounds per Square Inch
Flat	581,395
Grooved	212,766
Cupped	146,413

Machinery

Ball bearings do not differ from other elements of mechanism, in that they must be used in conformity with their individual characteristics. Directions for correct mounting that are hereafter cited must be absolutely adhered to under penalty of failure. A strict adherence to all of the directions—and they are neither many nor troublesome—will result in a reliability as near to absolute as even the most exacting can expect—a reliability far beyond that of any other form of journal—and such reliability is gained with the advantages of a practical absence of friction, small space occupied, and the minimum of attendance. Surely there are advantages enough to make a careful study and following of the directions worth while.

1. The proper size selection for the load must be made. Rated capacities are usually for steady loads and speeds. Variations from these conditions demand recognition by corresponding variations of the listed capacity.

2. Bearings must be lubricated. The oft-repeated statement that ball bearings can be run without lubricant is pernicious.

3. Bearings must be kept free of grit, moisture and acid. This prohibits the use of lubricants that contain or develop free acids. It is entirely practicable, by very simple means, to follow injunctions 2 and 3.

4. The inner race must always be clamped solidly to the shaft, so that no vibration can cause it to turn. This requires that the shaft be ground perfectly true, in order that it may make contact with the race all around, not merely at a few points. Unless this is done, a peening action will start, resulting in looseness. The race itself should be mounted with a light press fit, and very solidly clamped between a nut and shoulder.

5. The outer race must be mounted in such a manner as to permit of a slow creeping of the race in its housing. This has two beneficial effects. First, it avoids any possibility of an undesired endwise cramping of the balls in the race; second, such minute wear as occurs in the ball path is distributed around the entire circumference of the latter. To accomplish these results the housing must be accurately bored to such a diameter that the outer race will be a sucking fit in it, and the race is either left entirely free endwise or is confined between shoulders which give it a slight endwise freedom amounting to 1/64 inch or less. Only one bearing on a shaft may be confined endwise in this manner, since otherwise expansion or errors in machining or workmanship would produce undesirable axial or endwise cramping.

6. The bearing enclosures must retain oil or grease, while excluding dust and water.

Finally, after having observed all these precautions, submit your design to the bearing manufacturer and get the benefit of his experience. By so doing, many little things which you, from your experience may consider of minor importance, but which his broader experience shows him are pernicious, may be avoided.

In the ball bearing we have not a point contact as many suppose, but a substantial area due partly to deformation and partly to the shape of the parts in contact; I refer to the concavity of the ball path or groove whose radius in one direction very nearly coincides with that of the ball. This was very clearly brought out in a test which the Hess-Bright Mfg. Co. made a short time ago. Balls 1½ inch in diameter, in contact with a flat disk, a grooved disk, and a cupped disk, as shown in Fig. 9, were subjected to a load of 10,000 pounds in the testing machine. Vitriol was applied around the contact points and allowed to etch the exposed surfaces, *i.e.*, those which were not actually in contact. Then the load was relieved and the contact diameter was measured by means of a micrometer microscope. In the cases of the flat and cupped disks, the areas of contact were circular, but in the case of the grooved disk, the area of contact was elongated resembling an ellipse. The pressure per unit area was computed and found to be in accordance with the tabulated results. This test shows clearly the reason for the increased carrying capacity of the curved (grooved) ball track type of bearing as against that type with flat or practically flat tracks. It is self-evident that the more closely the groove envelops the ball, the lower will be the pressure per unit area, and hence the greater will be the ability to carry the load.

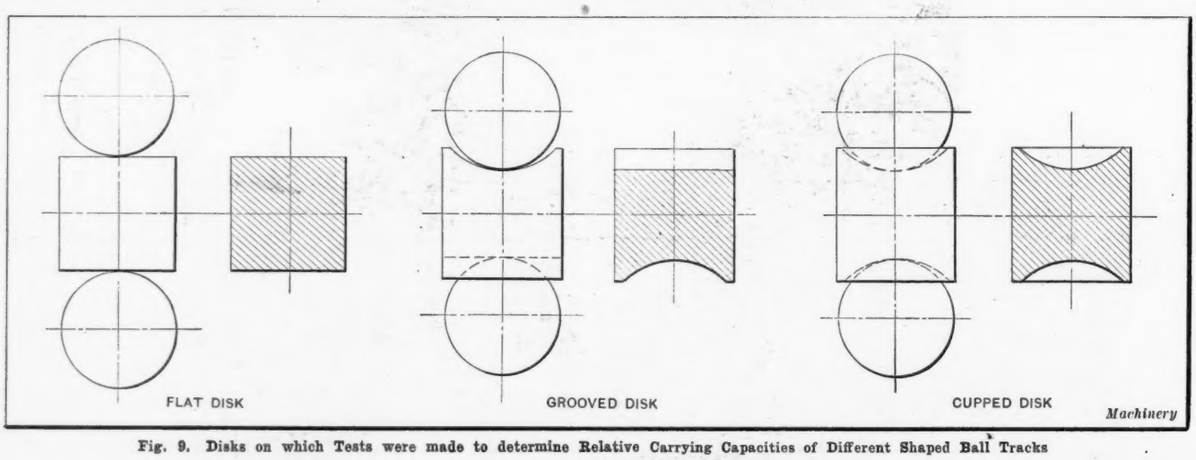

Fig. 9. Disks on which Tests were made to determine Relative Carrying Capacities of Different Shaped Ball Tracks

As an indication of the capacity and durability of ball bearings, I will give you the results of a test recently completed. A Hess-Bright No. 6407 bearing was subjected to a radial load of 3500 pounds and a thrust load of 1750 pounds, and run continuously at 1445 revolutions per minute for 531¼ hours before failure occurred. This bearing has a bore of 1.3780 inch, outside diameter of 3.9370 inches, and a width of 0.9843 inch. To get an idea of what the above radial and

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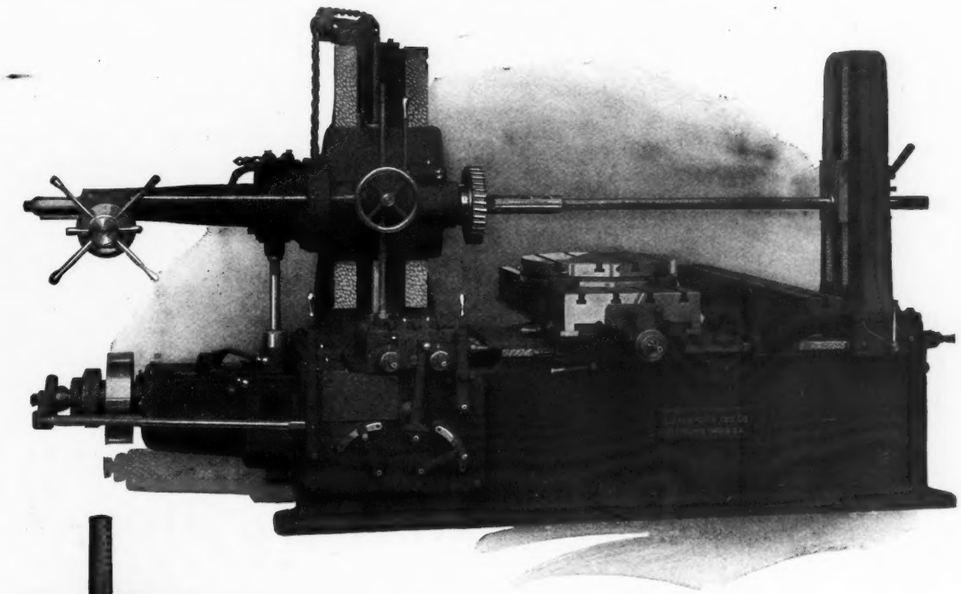

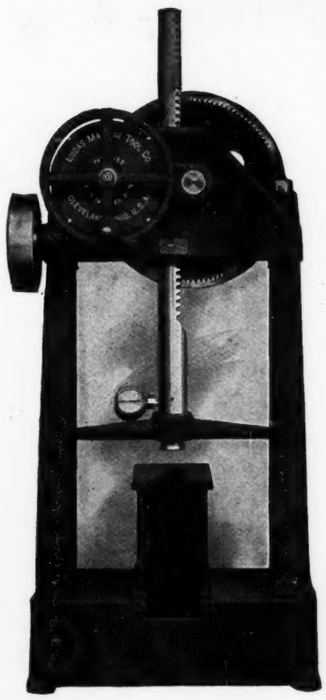

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thrust load figures would be the equivalent of, in automobile front hub service, let us assume the case of a 36-inch wheel running at 1445 revolutions per minute. This would mean a speed of 154.6 miles per hour. A run of 531¼ hours would be the equivalent of 154.6 × 531.25 or 82,141 miles. Also assume that two bearings are used to a hub, one carrying 3500 pounds radial load and 1750 pounds thrust, while the other carries 3500 pounds radial load only. The total radial load per hub would then amount to 7000 pounds, and with four hubs (assuming the rear hubs carry the same load as the front hubs—in the average car they carry more) the total load would be approximately 28,000 pounds. Based on the above, conservatively this would be the equivalent of 82,141 miles in the front hub of a car weighing (with the live load) 7000 pounds and running continuously at 154.6 miles per hour. (Allowing a factor of 4 for shock.)

The question of lubrication is a matter of such vital importance to the satisfactory operation of ball bearings that a paper of this character would hardly be complete without some reference to it. Some time ago we made a few tests of graphite oils and greases as ball bearing lubricants. We tested a Hess-Bright No. 308 bearing running under 100 per cent overload and using a graphite oil as the lubricant. The test was normal in every way and nothing unusual was noticed. After a run of 337 hours the bearing was removed and examined, and it was noticed that a considerable amount of wear had occurred—much more than was the case in similar tests where only a pure oil or light grease was used. The only conclusion we can draw from this is that the graphite in the oil, in spite of its being extremely finely divided and practically impalpable, had a slight abrasive action, and that it does not improve the running qualities of the bearing. On the contrary it is slightly injurious and tends to increase the friction slightly over that when oil alone is used.

Another test was conducted with a graphite grease which the manufacturers recommend for the lubrication of ball and roller bearings. It was a heavy grease with finely pulverized graphite. A trial was made of this by putting a quantity into the thrust bearings of one of the heads of our endurance testing machine. After a run of a few days the head became very noisy and finally "locked" the shaft. Examination of the bearings disclosed very distinct and somewhat irregular markings in the ball tracks—something like long "chatter marks"—as if the graphite had caused each ball to slide a short distance, thus slightly abrading the surface of the steel, until a little mound of the graphite had packed so hard under the ball that it was forced to roll over, only to repeat the sliding until another mound of graphite had packed under it. These results show clearly that graphite has no value in so far as reduction of ball bearing friction is concerned, and while it may be of considerable value to the other elements carried upon the ball bearings themselves, such as transmission gears, etc., the possible source of damage to the ball bearings cannot be overlooked.

The effect of speed upon the choice of lubricants should also be considered. As a general statement, it may be said that greases are suitable for low speeds, while oils are preferable for high speeds. Oil is really the better all around lubricant. It should be of sufficient viscosity to maintain a film between the pressure surfaces and the quantity used should only be enough to cover the surfaces—at high speed—the less, the better. Oil is more difficult to retain in the bearing box than grease. This, however, is merely a detail of design, since it is an easy matter to design a box that will not leak oil, and then it is simply a question of good workmanship to make sure that the joints are tight.

In conclusion, I feel that a few "Dont's" for ball bearing users would not be out of place, especially since the majority of us are users of ball bearings in one way or other. These "Don'ts" are particularly for the automobile owner, but are also generally applicable to the user of any machinery having ball bearings, as they stand for principles which are of universal application.

Don't let the bearing fill up with grit.

Don't hammer the races of the ball bearings.

Don't let acid get into the bearing. Always use a neutral lubricant.

Don't let water get into the bearing. In washing an automobile, especially the wheel hubs, be careful not to let the stream of water under city pressure play directly against the inner end of the hub.

Don't let oil leak out of the bearing.

Don't believe the man who says a ball bearing will run without oil.

Don't use grease containing foreign fillers such as sawdust, ground cork, etc. These may be of value in deadening the sound of gears, but they are injurious to ball bearings.

Don't take a bearing apart. If you want to play with it get an extra one.

Don't put new balls in—send the bearing to the manufacturer if you think they are needed.

Don't set a thrust bearing up until it resists rotation. Ball bearing friction is so low as to be perceptible to the touch only under excessive loads.

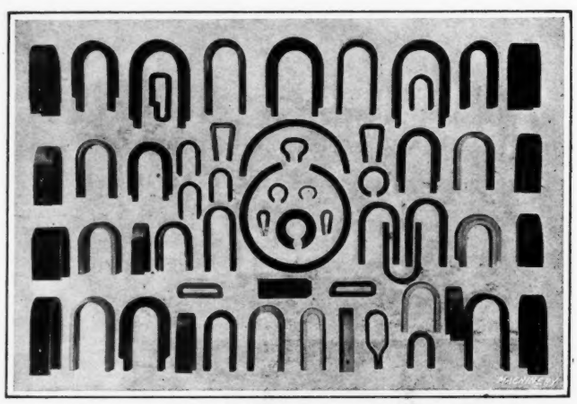
Don't tamper with the locks provided by the car builder—they are provided for the express purpose of keeping you from making adjustments.

When in doubt, communicate with the bearing manufacturer or his qualified representative.

* * *

PERMANENT MAGNETS MADE IN AMERICA

The forms of permanent magnets shown in the accompanying illustration are manufactured by the Esterline Co., Indianapolis, Ind. These magnets are used in such electrical instruments as watt-hour meters, ignition magnetos, etc. For use in handling this work, the Esterline Co. has built special machines for testing magnet steel and permanent magnets, which enable rapid determinations to be made of



A Collection of Permanent Magnets made by the Esterline Co.

the quality of the steel which is used, and also of the properties of the finished magnets. Every lot of steel is tested at the time it comes to the factory and the finished magnets are subjected to careful tests before they are passed by the inspection department. Mr. J. W. Esterline, president and general manager of the Esterline Co., was for a number of years chairman of the Committee on the Magnetic Properties of Iron and Steel of the American Society for Testing Materials, and is a recognized authority on this important subject.

* * *

The standards committee of the Society of Automobile Engineers, having investigated the cotter sizes used by automobile manufacturers, found that some of the car manufacturing concerns are at present carrying 250 sizes of cotter pins in stock. After carefully considering all the factors involved, a table of forty-one cotter pins of various lengths and diameters was formulated, in the belief that it provides an adequate number of sizes for use in motor car practice. In connection with the proposed standard cotter pin table, a table of suggested practice for the application of cotter pins with relation to the diameter of the bolt of the pin and the hole drilled therein has also been prepared.

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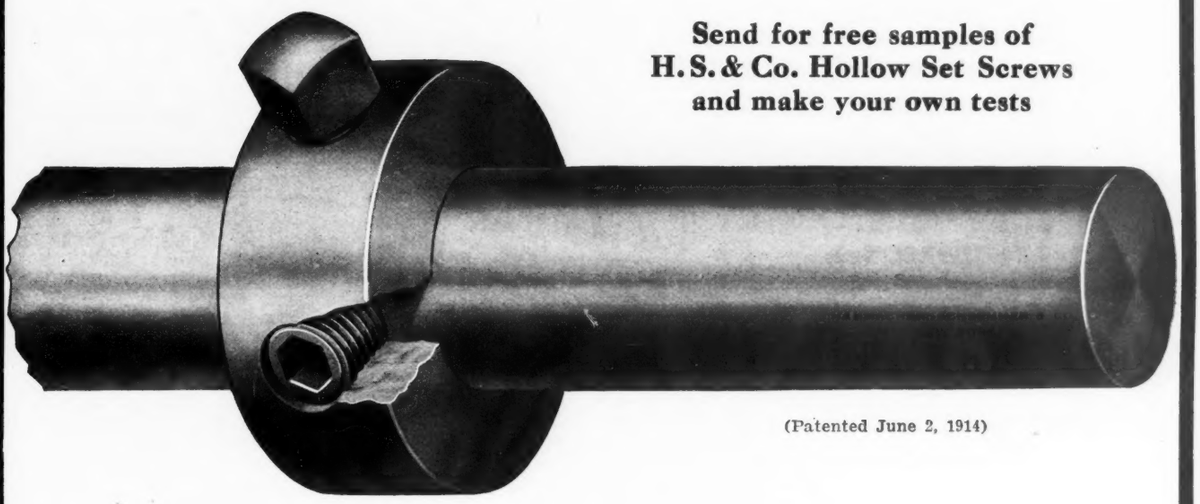

(Patented June 2, 1914)

The H. S. & Co. Hollow Set Screws have certain marked advantages, notably—

1st. Are tougher and "bite" better and therefore hold better.

2nd. Being made from sheet metal, they outlast and out-test any screw milled from solid bar.

3rd. Sides are absolutely uniform, insuring perfect fit of wrench.

4th. Holes are deeper, permitting wrench to come closer to point of screw, thereby insuring full tightening power.

Proper tests prove beyond a doubt that stamped screws are stronger and tougher than those milled from solid bar, owing to the position of the fibres of the steel. Well-known proof of this is found in the comparative values of semi-finished nuts, those milled from solid rod not being as strong as the stamped goods.

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FREDERICK W. TAYLOR'S WORK

In harmony with the request of Mrs. Frederick W. Taylor, Messrs. Carl G. Barth, Morris L. Cooke, James Mapes Dodge and H. K. Hathaway have taken steps to conserve his work and have arranged the following:

1. To provide for the continuation and extension of the Taylor system of management.
2. To gather together such materials as may be of use to his biographer.
3. To answer the correspondence which of late years has been coming in increasing volume from all parts of the world.
4. To complete the collection of books, data, etc., which would supply material for any memorial to Mr. Taylor.

These co-workers request all friends of Mr. Taylor and acquaintances who have correspondence or material of any kind which would be useful in carrying out the above purposes to send it to them. When requested, the material so sent will be returned to the owners. Correspondence with regard to this work should be addressed to Miss Frances Mitchell, Boxly, Highland Station, Chestnut Hill, Philadelphia.

* * *

PERSONALS

R. E. Ellis, sales manager of the Steinle Turret Machine Co., Madison, Wis., has resigned his position.

Frank H. Seng, Jr., of Waterbury, Conn., has become sales manager of the Whitcomb-Blaisdell Machine Tool Co. of Worcester, Mass.

E. E. Winship, formerly manager of the Cincinnati branch of Manning, Maxwell & Moore, Inc., has been appointed manager of the Cleveland branch.

Fred A. Bigelow has been appointed general sales manager of the Carpenter Steel Co., with headquarters at Reading, Pa. Mr. Bigelow succeeds John E. Sullivan, resigned.

C. H. Overkamp, formerly of the Conover-Overkamp Machine Tool Co., Dayton, Ohio, has been made manager of the Cincinnati office of Manning, Maxwell & Moore, Inc.

J. M. Riordan, formerly with the Fellows Gear Shaper Co., with headquarters at Cleveland, Ohio, is now associated with the Grant Lees Gears Co. of Cleveland, Ohio, as sales engineer.

Samuel Insull was presented with the sculptor's model of the Franklin medal, by the Franklin Institute, May 19. Mr. Insull delivered an address, "Electricity and Modern Industrial Growth."

Louis S. Jones, for several years connected with the Lumen Bearing Co., Buffalo, N. Y., and well known in the machinery trade, has been appointed sales manager. Mr. Jones will make his headquarters at Buffalo.

John Calder presented a paper: "Metal Spraying Processes in Engineering and Art," at the monthly meeting of the American Society of Mechanical Engineers in the Engineering Societies Bldg., New York City, Tuesday evening, May 11.

George A. Wheeler, deceased, was recently awarded the Edward Longstreth medal of merit for his escalator, an inclined elevator for transporting persons from one level to another. The basic invention was first disclosed in the patent granted to Mr. Wheeler in 1892.

Thomas A. Edison was presented with the Franklin Medal, May 19, in recognition of "the value of numerous basic inventions and discoveries forming the foundation of world-wide industries, signally contributing to the well-being, comfort and pleasure of the human race."

Herbert Alfred Humphrey of London, England, and Cav. Ing. Alberto Cerasoli of Rome, Italy, were recently awarded the John Scott Legacy medal and premium for the invention and development of the Humphrey pump, a device for raising water by the direct application of the explosive energy of a mixture of combustible gas and air.

Alonzo B. See, of the A. B. See Electric Elevator Co., New York City, delivered an address on patents before the Elevator Manufacturers Association of the United States, at their banquet held at the Waldorf-Astoria Hotel, April 15, 1915. Mr. See referred caustically to some of the inconsistencies of the decisions in patent infringement cases.

A. W. Van Buren has joined the sales force of the E. L. Essley Machinery Co., Chicago, Ill., dealer in iron and brass-working machinery. Mr. Van Buren was connected with the Chicago office of the Niles-Bement-Pond Co. for about seventeen years and represented the company in Wisconsin, Minnesota and parts of Illinois. He will represent the E. L. Essley Machinery Co. in the Chicago territory.

Charles Spalding, sales representative of the Gisholt Machine Co., Madison, Wis., who has heretofore made his headquarters at the company's Chicago office, is now located at Detroit and will make his headquarters there, taking care of the Chicago territory, the same as heretofore. Mr. Spalding's home address is 2161 West Grand Blvd., and his mail address is care of Detroit Athletic Club, Detroit, Mich.

H. E. Preston, formerly with the American Can Co., and prior to that with the Felt & Tarrant Mfg. Co., Chicago, has joined the sales force of the Gisholt Machine Co., Madison, Wis., periodograph department, his headquarters being at the Chicago office, 208 S. La Salle St. Mr. Preston will look after the company's periodograph interests in the Chicago district.

Alex Schwalbach, advertising and publicity man for the F. & S. bearings imported by the former J. S. Bretz Co., and their successor, the Bearings Co. of America, leaves the employ of the Bearings Co. of America June 1, after six years' service. Mr. Schwalbach is an all-around newspaper man and also has had a long selling experience in the bicycle, motorcycle and automobile lines.

Frederick Haynes Newell was recently appointed professor of civil engineering and head of the department of civil engineering of the University of Illinois, Urbana, Ill. Prof. Newell comes from actual professional work, having been for twenty-six years in the government service, principally as chief engineer and later as director of the United States Reclamation Service.

Heike Kamerlingh Onnes was awarded the Franklin Medal, May 19, in recognition of his "long continued and indefatigable labors in low-temperature research which has enriched physical science, not only with a great number of new methods and ingenious devices, but also with achievements and discoveries of the first magnitude." Prof. Onnes is director of the physical laboratory of the University of Leiden, Holland.

Douglas T. Hamilton, associate editor of MACHINERY, spoke at the meeting of the American Society of Swedish Engineers, Brooklyn, N. Y., Saturday evening, May 8, on "Shrapnel and Shrapnel Manufacture." The subject created considerable interest, as several of the engineers present are engaged in this line of manufacture, and a discussion which brought out several interesting points followed Mr. Hamilton's presentation.

* * *

OBITUARIES

Daniel W. Edgecomb, inventor, astronomer and manufacturer of telescopes, died at his home in Fairfield, Conn., aged seventy-five years.

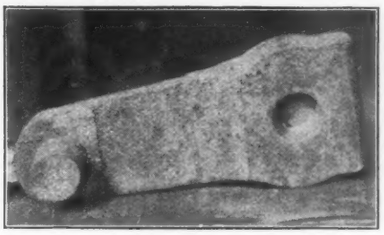
John Birkinbine, a noted mining engineer and ex-president of the American Institute of Mining Engineers, died at his home in Philadelphia May 14, aged seventy-one years.

Horace L. Arnold, a well-known contributor to the technical journals, author of several books, inventor and all-around mechanic, died in Detroit, Mich., recently, aged about seventy-five years. Mr. Arnold lately made a notable contribution to the *Engineering Magazine*, it being a description and analysis of the methods and conditions found in the plant of the Ford Motor Co., Detroit.

David M. Parry, ex-president of the National Association of Manufacturers, died at his home in Indianapolis, May 12, aged sixty-three years. He was born on a farm near Pittsburg, Pa. In the early seventies he was a reporter on the *New York Herald*, and later became an owner of a newspaper published in Montana. In 1882, he acquired a wagon shop in Rushville, Ind., and removed the business to Indianapolis, where it developed into one of the largest of its kind in the world, having an output of one thousand vehicles a day. Mr. Parry founded the Overland Automobile Co., which he later sold to his former superintendent, John Willys, for $250,000. He is alleged to have given Henry Ford his first financial assistance when starting in the automobile business. In 1903 he was elected president of the Industrial Association of America, which consisted of a federation of the employers' associations and citizens' alliances throughout the country, formed to resist the demands of organized labor. He had many interests besides his vehicle business, and was an author of some note. He is survided by a widow and nine children.

George T. Reiss, vice-president of the Niles Tool Works Co., Hamilton, Ohio, and a director of the Niles-Bement-Pond Co., New York City, died May 5 at his country home near Hamilton, aged sixty-five years. Mr. Reiss was born in Cincinnati and moved to Hamilton in 1877. He was first employed as a draftsman at the old Cope and Maxwell shops, and in 1878 was placed in charge as the master machinist of the engineering department of the Niles Tool Works which had removed from Cincinnati to Hamilton in 1871. He was the chief mechanical engineer of the concern and later became superintendent of the drafting department and was subsequently elected a member of the board of directors, of which he was also secretary. Upon the death of the late Col. Alexander Gordon and the accession of James K. Cullen to

SAVING HALF on Machine Work



A rectangular billet, 5 x 7 at the large end, 4 x 7 at the smaller, is placed with the large end in a vertical press and squeezed to shape 10½ inches wide by 4 inches thick. The body is squeezed to a thickness of 2 inches, leaving a lump on the lower end. The lower end is heated and tapered on a steam hammer and placed in the dies and upset.

The cost on this machine part made by hand methods in a large Chicago shop was $25.60. A large part of this cost was in machining the rough stock.

Today the machining cost has been cut in half by forging the piece to nearly the correct dimensions on

AJAX Universal Forging Machine

Trade Mark Registered

This machine is a 6-inch size, one of the largest manufactured, and has been used for many other remarkable jobs.

But this is only an average example of the work that can be done in any shop equipped with Ajax machinery.

Ajax engineers will take the entire responsibility of investigating and telling you just what can be done on any pieces you may select. We stand behind them on any production rate they promise.

THE AJAX MANUFACTURING CO.

New York Office
1369 Hudson Terminal

CLEVELAND, OHIO

621 Marquette Building
Chicago, Ill.

The Ajax Universal Forging Machine

In addition to the forging machine, this Ajax machine is equipped with a powerful vertical press for accessory operations, such as squeezing and forming or welding scrap stock to produce pieces required for large forgings.

the presidency of the directorate, Mr. Reiss became vice-president, which position he retained until his death. Mr. Reiss was a prolific inventor and many patents for tools and machinery were granted him.

Albert D. Goodell, one of the founders of the Goodell-Pratt Co., Greenfield, Mass., manufacturer of mechanical tools, died at his home in Shelburne Falls, Mass., aged sixty-nine years. He learned the trade of a carpenter in his youth and followed it about five years. In this work, he displayed unusual ingenuity and mechanical ability. In 1870 he was called to Millers Falls to take a position with the Millers Falls Co. as superintendent and master mechanic, and during his connection with that concern he made many valuable inventions. Mr. Goodell formed the company known as Goodell Bros. with his brother, Henry G. Goodell, now of Greenfield. In 1888 he engaged in the manufacture of mechanical tools in Shelburne Falls. After four years of partnership, he sold his interest to his brother Henry, who moved the business to Greenfield, where it still continues greatly enlarged under the name of the Goodell-Pratt Co. After disposing of his interest in this business, Mr. Goodell moved to Worcester, where he and his son, Frederick A. Goodell, established the Goodell Tool Co. In 1893, the business was transferred to Shelburne Falls.

COMING EVENTS

June 3-5.—Joint convention of the American Supply & Machinery Manufacturers' Association and the National Supply & Machinery Dealers' Association. Hotel Bellevue-Stratford, headquarters, Philadelphia, Pa.

June 7-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-17.—Summer meeting of the Society of Automobile Engineers on board the steamer "Noronic" of the Northern Navigation Co., leaving Detroit June 14. Coker F. Clarkson, secretary, 1745 Broadway, New York City.

June 19-26.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

June 20-24.—Eleventh annual convention of the Associated Advertising Clubs of the World, Chicago, Ill. The program includes a notable list of speakers, many of them being of national prominence.

June 22-25.—Spring meeting of the American Society of Mechanical Engineers at Buffalo, N. Y. David Bell, chairman of the general committee, Buffalo; C. W. Rice, secretary, 29 W. 39th St., New York City.

June 22-26.—Annual convention of the American Society for Testing Materials. Hotel Traymore, Atlantic City, N. J., headquarters. Edward Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 19-21.—Seventh annual convention of the American Railway Tool Foremen's Association, Chicago, Ill. Hotel Sherman, headquarters, Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 7-10.—Twenty-third annual convention of the Traveling Engineers' Association, Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, East Buffalo, N. Y.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry and Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

NEW CATALOGUES AND CIRCULARS

Sanitary Fountain & Specialty Co., 176 Federal St., Boston, Mass. Circular of sanitary bubbling fountains for offices, shops, mills, factories, etc.

B. C. Ames Co., Waltham, Mass. Catalogue illustrating and giving prices of the line of dial gages manufactured by this company.

Crescent Tool Co., Jamestown, N. Y. Circulars of the "Crescent" hammer handle screw-driver and the "Crescent" adjustable single- and double-end wrench.

Schum Bros., Metropolitan Tower, New York City. Circular on the Schum "Absolutely Positive" nut lock, which is automatically locked by means of a set-screw.

Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Circular No. 210 on Link-Belt wagon and truck loaders for handling coal, coke, stone, sand, and similar loose materials from storage.

W. Robertson Machine & Foundry Co., Buffalo, N. Y. Folder illustrating "Economy" high-speed power saws in various sizes. The claims made for these tools are speed, accuracy and economy of blades.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 103 on Hisey portable electric hand and breast drills, describing twenty styles and sizes for operation on direct current and alternating current, and the universal motor type for operation on direct and alternating current of the same voltage.

Gould & Eberhardt, Newark, N. J. 1915 catalogue on high-duty shapers and attachments, containing detailed description of the shapers of this company's manufacture, and illustrating tool-room shapers, extension base shapers, "Invincible" type shapers, etc.

Mortimer J. Silverberg, Peoples Gas Bldg., Chicago, Ill. Circular of a time study watch which gives direct reading in operations per hour, eliminating mental and pencil computations. It has a decimal dial with "take out time" feature and stem actuated set back. The price of the watch is $15.

Dodge Sales & Engineering Co., Mishawaka, Ind., distributor of the product of the Dodge Mfg. Co., of Mishawaka, has issued a new catalogue covering the full line of Dodge gearing. For a number of years the Dodge Mfg. Co. has made a specialty of transmission gearing, and the line embraces many thousands of patterns.

Vulcan Process Co., Minneapolis, Minn. Catalogue 4 of the "Vulcan" process of oxy-acetylene welding and cutting of metals, describing torches, acetylene gas generators, regulators, cutting and welding portable plants, examples of work repaired, and general information of interest to garages, repair plants and manufacturing concerns that can make apparatus of this sort useful.

National Twist Drill & Tool Co., Detroit, Mich. Catalogue 8, 176 pages, 4½ by 7½ inches, on carbon and high-speed twist drills, reamers, counterbores, milling cutters, end mills, hollow mills, and involute gear cutters. The tabular matter giving data on B. & S. tapers, Morse tapers, speed and feed of drills, decimal equivalents, weights of round and square steel and sizes of tap drills will be found of value.

Cincinnati Iron & Steel Co., Cincinnati, Ohio. Illustrated booklet showing views of the plant, warehouses and facilities for handling and fabricating structural steel, beams, angles, channels, tees, plates, bars, etc. The "Cisco" lathe is also illustrated. The next is entitled "Lucid Lucubrations of Luke McLuke" and consists of aphorisms intended to relieve the monotony of life of the "tired business man."

Rockford Iron Works, Rockford, Ill. Folder entitled "There With The Punch," illustrating Rockford straight-side flywheel press, straight-side double crank geared press, straight-side flywheel press with side shear, and inclinable flywheel press. Rockford straight-side presses are furnished in sizes of from 50 to 300 tons pressure. The folder has an illuminated cover and the illustrations are made to a large scale, giving an excellent idea of these presses.

George Shipper, Aurora, Ind. Circular of the Shipper automatic gear planing machine, designed for planing spur gears with formed cutters. The cutter slide operates horizontally and the gear blanks are rigidly supported, the design being worked out with the view of making a high-production machine. Means are provided for quickly changing speeds and feeds without removing change gears. The machine has a capacity for spur gears up to twenty-eight inches diameter by eight inches face.

Watson-Stillman Co., 192 Fulton St., New York City. Sectional catalogue 92 of hydraulic forcing and miscellaneous presses, comprising wheel presses, crank-pin presses, armature presses, broaching presses, reversed cylinder forcing presses, die presses, horizontal forcing presses, multiple cylinder projectile banding presses, projectile capping and banding presses, spring banding presses, baling presses, sheet steel scrap baling presses, box baling presses, auto truck tire forcing presses, briquetting presses, lead presses, bulldozers, etc.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Pamphlet descriptive of Beaudry motor-driven hammers, made in two styles, viz., the "Peerless" with rams weighing from 25 to 200 pounds, and the "Champion" with rams weighing from 50 to 500 pounds. The "Champion" hammer is equipped with a friction clutch pulley on the hammer, pressure on the foot-treadle engaging the clutch and starting the hammer, the same variation in speed and force of blow being obtained as with the loose belt and idle pulley of the belt-driven type.

Hoover Steel Ball Co., Ann Arbor, Mich. Consolidated price list of micro-chrome steel balls, chrome-nickel steel balls, special carbon crucible steel balls, steel burnishing balls, solid brass, bronze and bell metal balls, acid-resisting hollow bronze balls and aluminum balls. Miscellaneous data are given on weights of steel balls, rules for finding diameter and radius of enclosing circle of a ring of balls, decimal equivalents of parts of an inch, decimal equivalents of millimeters and fractions of millimeters, and allowable loads for chrome and special steel balls.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. General catalogue on drop-forgings and drop-forged tools. 160 pages, 6 by 9 inches. The tools shown are: drop-forged wrenches, new improved line of "Agrippa" tool-holders, lathe dogs, clamps, caliper gages, thumb-nuts and screws, eye-bolts, swivels, hoist hooks, wire rope sockets, handles, pipe-fitters' tools and gas engine forgings. The wrenches listed in this catalogue include about 800 sizes and 40 patterns, with a range of openings from 5/16 inch to 7 5/8 inches, accommodating every size of nut and screw.

Peerless Piston Ring Co., 91-107 Lafayette St., Newark, N. J. Circular of the "Peerless" positive triple eccentric "leak-proof" piston ring for automobile, marine, motorcycle and steam engines, air compressors, pumps, refrigerating machines, etc. The "Peerless" piston ring consists of three eccentric rings—two narrow and the third broad, equal in width to the other two; these are arranged with the broad ring inside of the two narrower rings which contact with the cylinder bore. The exterior rings are secured in a fixed position relative to the inner ring so that leakage under the rings is prevented.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Catalogue of S. K. F. self-aligning ball bearings, dealing with bearing construction, design of ball bearings, manufacture of ball bearings, instructions for mounting S. K. F. radial bearings, mounting thrust bearings, housings for S. K. F. ball bearings, bearing locking nuts, inspection and lubrication, selecting proper size and bearings, tables of S. K. F. ball bearings, tables of S. K. F. ball bearing hangers, applications in machine tools, automobiles, railway cars, textile machines, grain milling machinery, paper making machinery, electric motors and wood-working machinery.

Gleason Works, Rochester, N. Y. Folder illustrating and describing the spiral type bevel gear generator. This machine cuts bevel gears and pinions with spiral type teeth and is especially adapted to meet the demands of the automobile trade. The machine is regularly equipped for finish cutting only, but can be used for stocking out by changing the feed cam and the cutter. If a cam for rough cutting is wanted, this should be specified in the order as it is not part of the regular equipment. The folder includes spiral gear calculations of considerable value, for generating spiral gears in connection with the Gleason machine.

J. T. Slocomb Co., Providence, R. I. Pamphlet on accurate and economical measuring in machine construction by the use of micrometer calipers, entitled "The Measuring Book." The principle of the micrometer caliper is explained, and directions are given for reading micrometer calipers that are so simple that an apprentice can quickly comprehend them. Measuring with a scale and an ordinary caliper is compared with micrometer measurements, and the crudeness of the former method is pointed out. The special features of the Slocomb micrometer and the various sizes and combinations in sets are shown. The chapter on reliable measurements describes and illustrates the apparatus owned by the J. T. Slocomb Co. for fixing its standards. The pamphlet is one that can be read with interest and profit by all concerned with mechanical production.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Pamphlet entitled, "Machine Tools and Shop Equipment employing S. K. F. Ball Bearings"—a treatise of interest to mechanical engineers, designers, and users of machinery and machine tools in particular. In the foreword, the author calls attention to the importance of ball bearings, and to the changes made in the past decade by their introduction into machine tools and other machinery. Following this, ball bearing construction is taken up, and the importance of the construction which permits a ball bearing to adjust itself to deflections of the shaft is pointed out. Examples of the application of ball bearings to machine tools include drilling machines of the radial, multiple, and special types, heavy-duty turret lathes, automatic lathes, engine lathes, turning machines, milling machines, boring, drilling and milling machines, grinding machines, grinders and buffers, portable grinders, broaching machines, special machine tools, lineshafts, electric motors, etc. One notable example is an internal grinder, the spindle of which runs at 32,000 R. P. M. Ball bearings enable the spindle to be driven at a rate that yields a speed of 5500 feet per minute to the periphery of the grinding wheel. This, and many other examples, illustrate what a change is being made in machine tools by the introduction of efficient bearings. They make higher speeds possible, reduce friction losses and require less space in the length of the shafts.

ARMSTRONG TOOLS at the PANAMA-PACIFIC EXPOSITION
OUR WELCOME AWAITS YOU --- BLOCK 41 PALACE OF MACHINERY
WE ARE PREPARED TO MAKE PRACTICAL DEMONSTRATIONS SHOWING
THE EFFICIENCY, ECONOMY AND CONVENIENCE OF ARMSTRONG TOOLS
The ARMSTRONG TRADE MARK ON ANY TOOL MEANS THE BEST In DESIGN, MATERIAL and WORKMANSHIP
ARMSTRONG CHICAGO, U.S.A.
ALWAYS IN THE LEAD
HIGHEST AWARDS AT PARIS LIEGE ST. LOUIS
ALL KINDS ALL SIZES
DROP FORGED STEEL SUPERIOR QUALITY
WRENCHES
TOOL HOLDERS THAT HAVE MADE GOOD
ARMSTRONG BROS. TOOL CO. CHICAGO., U.S.A.

DETAILS OF THE ARMSTRONG EXHIBIT

Size of space, 31 x 32 feet; area, 992 square feet floor space.
Diameter of central revolving display stand, 14 feet divided into 12 panels.
Total length of plate glass show cases, 44 feet.

Exhibit consists of tool holders, ratchet drills, clamps, wrenches and lathe dogs.
Total number of tools in exhibit (no duplicates) 671.
Shipping weight of exhibit 18,000 pounds.

Attendant in charge JOSEPH C. FLETCHER.

The most prominent feature of this exhibit is the central revolving display stand surmounted by a large relief model of the earth and a huge gold arm and hammer which turns with the stand while the hammer rises and falls as if striking blow upon blow. On another stand in the rear center a complete line of ratchet drills is displayed, operating constantly in different positions and angles. The Armstrong Cutting-off and Grinding Machine shown is motor driven and used to demonstrate our patented process in cutting off and grinding high-speed cutters for Armstrong Tool Holders, while the lathe is used for demonstrating in a practical way the economy, convenience and efficiency of the Armstrong Tool Holder System.

The show cases are electric lighted and in them are displayed samples in various stages of manufacture from the rough forging to the finished tool.

TRADE NOTES

Selson Engineering Co., Ltd., of London, has established temporary offices at 78 Broad St., New York City.

Van Norman Machine Tool Co., Springfield, Mass., is planning to make two additions to its present factory which will practically double the floor space.

C & C Electric & Mfg. Co., Garwood, N. J., manufacturer of C & C motors, generators and electric arc welders, have removed their Chicago office to 911 First National Bank Bldg., Chicago, Ill.

Cleveland Clutch Co., Cleveland, Ohio, has been sold to the Reliance Gage & Column Co., 5902-5912 Carnegie Ave., Cleveland, Ohio. The Reliance Gage & Column Co. has recently completed a five-story factory building, and will be soon equipped to push the manufacture of clutches and pulleys.

Gunther-Wright Machine Co., Owensboro, Ky., has been succeeded by the Wright Machine Co., Inc., with a capital of $150,000. The company will manufacture gas engines, also excavating machines and wet dredge machines, equipped with both steam and oil engines. John S. Wright is president.

American Emery Wheel Works, Providence, R. I., is building a third floor addition, 50 by 100 feet, to a part of its works, which will be used exclusively for office space. The present offices will be turned into additional shop space. The increase of shop space was made necessary by the demands of the business.

Detroit Stamping Co., 955-957 West Fort St., Detroit, Mich., a concern recently organized, is now located in a new plant at the above address. The members of the firm are men who have had much experience in making stampings, dies, and machine work, and they are prepared to give prompt and efficient service.

Carpenter Steel Co., Reading, Pa., has appointed Fred A. Bigelow general sales manager, succeeding John E. Sullivan, resigned, with headquarters at Reading, Pa. James W. Sederquist has been appointed western sales manager, succeeding Mr. Bigelow, with office and branch warehouse at 400 Lakeside Ave., N. W., Cleveland, Ohio.

Joseph Dixon Crucible Co., Jersey City, N. J. The annual meeting of the stockholders was held in Jersey City, April 19, and after the election of directors the following officers were elected: George T. Smith, president; George E. Long, vice-president; J. H. Schermerhorn, treasurer; Harry Dailey, secretary; Albert Norris, assistant secretary and assistant treasurer.

James McKay Co., Pittsburg, Pa., has erected a forging plant at McKees Rocks, Pa., for the production of crankshafts, cam-shafts, connecting-rods and other miscellaneous forgings, for use in the manufacture of automobiles. Board and steam drop-hammers have been installed, ranging in weight from 200 to 9000 pounds; also forging and forming presses, and a complete heat-treating system.

Peter A. Frasse & Co., Inc., 417-421 Canal St., New York City, has been made distributor for the line of polishing and plating supplies manufactured by the Munning-Loeb Co. C. G. Backus, engineer and buffing expert, may be consulted at the office of Peter A. Frasse & Co., Inc., at any time. He will offer expert advice to those desiring to obtain best results in their buffing and plating departments.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has purchased the plant and business of the J. Stevens Arms & Tool Co., Chicopee Falls, Mass., and the plants of the Stevens-Duryea Co. at Chicopee Falls and East Springfield, Mass. These plants will be used for the manufacture of army rifles. The Westinghouse Electric & Mfg. Co. has secured a large contract for guns, and will employ about 8000 men for their manufacture.

International High Speed Steel Co., 478 Pearl St., New York City, is erecting a steel plant at Rockaway, N. J., which is rapidly nearing completion. It is expected that the new plant will be in full operation by the latter part of June. The product will be confined to the highest quality of tool steels, alloy steels, high-speed steels of all shapes and sizes, solid octagon and cruciform, and hollow hexagon and round rock drill steels, for which the company has achieved a reputation in its "Bulldog" brand.

E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has opened an office and warerooms at 622 West Washington Blvd., Chicago, Ill., to take care of the greatly increased volume of its business in the Middle West. Customers will be able to obtain direct from the staff of salesmen connected with this office, up-to-the-minute information and details regarding the latest developments in the Bliss lines of machinery. A line of standard presses and parts will be kept in stock for immediate delivery. A Detroit office also has been opened in the Dime Bank Bldg., Room 2011, which offers the same service to customers.

O. S. Walker & Co., Worcester, Mass., a partnership, has been dissolved and a stock company has been formed to manufacture the Walker magnetic chucks and Walker grinders. The Walker Grinder Co. has been consolidated with O. S. Walker & Co., and the consolidation incorporated as a stock company. The new concern, incorporated under the name of O. S. Walker Co., with a capital stock of $90,000 paid in, will manufacture an enlarged and improved line of Walker magnetic chucks and the various types of Walker piston ring and surface and tool-room grinders. O. S. Walker is president and treasurer, and I. F. Williams secretary and manager.

Purchasing Agents' Association of New York is an organization recently formed, composed entirely of purchasing agents and devoted exclusively to their interests. The organization now comprises over one hundred members and a membership of two hundred is in sight. The membership fee is $10, payable annually in advance. The monthly meetings are held on the third Tuesday of each month. Noon meetings are also held every Thursday. The object of the association is to study methods, systems, etc., of purchasing departments. The officers are: W. B. Murdock, president; F. G. Idler, first vice-president; C. D. Massey, second vice-president; J. I. McComb, treasurer; E. B. Hendricks, secretary, 129 Lafayette St., New York City.

Fox Machine Co., Grand Rapids, Mich., manufacturer of multiple-spindle drilling machines, tube cutters, milling machines, universal wood trimmers, miter machines, etc., was started by W. R. Fox in 1886, and the business was incorporated in 1892 with a capital of $150,000. In 1896, Mr. Fox took up experimental work on typewriters and began the manufacture of typewriters in 1898. In 1902 he organized the Fox Typewriter Co., turning over to it the machine business. He has now re-purchased from the Fox Typewriter Co. the machinery business sold to it in 1902, and this business will be carried on under the name of the Fox Machine Co., manufacturing the same line of tools as heretofore. The company is employing at present 125 men, and has for the past three months been working twenty-three hours a day, having just completed an order for the Remington Arms & Ammunition Co. for 200 milling machines. Plans are being drawn for a new building 90 by 300 feet which will be built in some suitable location in southern Michigan, northern Ohio or Indiana. The business will be moved as soon as a suitable place is found.

Classified Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

HELP WANTED

HIGH-GRADE FOREMAN TOOL-MAKER for large machine shop. Expert executive on jigs, fixtures, cutters, hobs, and forming tools for automatic machines. Good position for right man. Apply BOSTON GEAR WORKS, Norfolk Downs, Mass.

DRAFTSMAN, first-class, experienced on dies, jigs and fixtures, etc. State age, experience in full and salary required. Apply THE CANADIAN CROCKER-WHEELER COMPANY, Limited, St. Catharines, Ontario.

WANTED.—A man capable of taking charge of forty machinists and tool-makers, and producing results. In your first letter tell all about your experience, what you know you can do and who you did it for. Unless you can build accurate automatic machinery and tools economically, don't apply. Box 740, care MACHINERY, 148 Lafayette St., New York.

SUPERINTENDENT for shop manufacturing electric controlling apparatus. We want a man who has had experience in systematic superintendence, and capable of taking complete charge of moderate size shop and securing results and efficiency. Good opportunity for right man. Box 738, care MACHINERY, 148 Lafayette St., New York.

WANTED AGENTS.—Saunders' Pocket "Hand Book of Practical Mechanics" for tool chest $1.00 only. Why pay more? It fills bill for shop kinks, ready reference, simple arithmetic. Send for circular. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

HIGH-CLASS SALESMAN having acquaintance in Chicago territory and Central West to sell leather and textile belting. Box 741, care MACHINERY, 148 Lafayette St., New York.

CONTRACT WORK

HARDENING, CARBONIZING, GALVANIZING. C. U. SCOTT, Head of Wall St., Davenport, Iowa.

AUTOMATIC AND SPECIAL MACHINES designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

WE ARE EXCEPTIONALLY WELL FITTED to build your light and medium weight machines on contract in reasonable lots. Can store finished material, shipping direct to consumer your single orders or in lots and take the factory end entirely off your hands. Best of shipping facilities. Prompt and efficient service. High-class workmanship. Prices right. HOYSRADT & CASE, Kingston, N. Y.

SITUATIONS WANTED

EXPERT MECHANICAL DRAFTSMAN with 15 years of practical shop and drafting-room experience desires change of position as foreman in shop or drafting-room. Country preferred. Box 739, care MACHINERY, 148 Lafayette St., New York.

MANUFACTURERS' AGENT. — Boston headquarters—covering New England, wants to enlarge operations. An exclusive line is desired, selling to manufacturers and mills. We are established and are getting results. Box 712, care MACHINERY, 148 Lafayette St., New York.

MACHINE SHOP FOREMAN.—Now in charge of brass and machine work; 5 years in charge of machine tool work; 35 years old. Can give best of references. Box 737, care MACHINERY, 148 Lafayette St., New York.

FOR SALE

GET A "LAST-WORD."—The Test Indicator Par Excellence. H. A. LOWE, 1374 E. 88th St., Cleveland, O.

ATTENTION! MACHINISTS.—$1.00 buys Saunders' Pocket "Hand Book of Practical Mechanics." Increase your salary. It gets there. Send for circular. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

MACHINISTS AND TOOL-MAKERS.—The Progressive Machinists Manual. Biggest small reference book for the shop. Unique features. Vest pocket size. Strong, flexible covers. Price, 25 cents. WM. CUTHBERTSON, 39 Springside Ave., Pittsfield, Mass.

21 PIECE WESTERN ELECTRIC CO. INTERCOMMUNICATING TELEPHONE EQUIPMENT. Fine proposition for private factory and office telephone. No "central" needed. A bargain to some concern interested. Write EARLE M. SCOTT, Pur. Agt., Jas. H. Matthews & Co., Inc., Pittsburgh, Pa.

ONE OXY-ACETYLENE WELDING APPARATUS, manufactured by the Linde Air Products Co., including Type F oxy pressure regulator, Fig. 11 oxy regulator, Fig. 4 blow pipe, six welding heads and gas tanks (no generator). Write MERRELL-SOULE CO., Syracuse, N. Y.

THOMPSON METAL JIG SAW with direct connected 110 V D C gear drive motor 550 to 1100 R. P. M. Will sell either with or without motor at option of purchaser. For further information and price, write EARLE M. SCOTT, Pur. Agt., Jas. H. Matthews & Co., Inc., Pittsburgh, Pa.

EMPLOYMENT AGENCIES

UNDERSIGNED COUNSEL will confidentially negotiate preliminaries for important executive, technical, administrative, manufacturing, and professional positions, insuring strictest privacy. Though listed as an agency (for want of a more explicit heading) there is no commission nor contract involved in my service, but a counsel fee for actual service only. $2,500 to $15,000 men exclusively. Send only your name and address for prefatory details. R. W. BIXBY, Lock Box 134-L2, Buffalo, N. Y.

PATENTS

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps. U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information.

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